THE

POPULAR SCIENCE MONTHLY.

SEPTEMBER, 1882.

ELECTRIC AND GAS ILLUMINATION.

By C. M. LUNGREN.

THE period of contest and denial over the question of the possibility of producing a light of low intensity by means of electricity, that would be suitable for the general purposes of interior lighting, has about drawn to a close. It is now pretty generally conceded—what there has never been any reason for denying—that the known laws of electric transmission interpose no bar to the successful solution of the problem, but that the difficulties in the way are solely of a practical kind. And it is, further, quite generally agreed that these practical difficulties have been for the most part resolved, and the question reduced down to one of cost simply; and, while a good deal of discussion has taken place upon this point, but little has been written that will enable the general public to form a judgment upon the subject, and arrive at a trustworthy opinion of the relative cost of it and gas under actual commercial conditions.

In estimating the relative cost of the two illuminants, it has been common to compare simply the cost of the materials consumed in their production, or, when the cost of the apparatus necessary to generate the electricity has been taken into account, this has usually been upon the basis of a limited production, and, to this extent, unfair to electricity. A comparison, to be of any value, should be between plants of a size sufficient to reduce the cost to the lowest point at which it can be commercially maintained, and should include all of the items entering into it. The attempt has been made, in the following pages, to institute such a comparison, and present the facts in the case as they are, so far as they can be obtained. The comparison is upon the basis of works capable of producing a million feet a day, as, in such works, gas can be made as cheaply as in any that are

larger. The figures for the electric plant are based upon the work of Mr. Edison, as he is the only one who has so far made any attempt to put in an electric plant upon an industrial scale. And, for that reason further, only his system of distribution is considered, though it may be a question whether it is the one which will prove most satisfactory in practice. An objection to it of considerable force in the opinion of some, is, the difficulty of handling engines and boilers with sufficient rapidity to meet great and sudden variations of demand, such as not unfrequently occur during the seasons of the year in which the weather is changeable. The variation that experience has shown takes place at different periods of the day can be met readily enough. On this account, and on account of the greater freedom secured in the matter of working various pieces of apparatus without interference, it would seem that the system of distribution which includes a storage-battery would be preferable, and may, perhaps, become the final form adopted in electric installations. It can not well enter into the present calculation, however, as there are no data with reference to the first cost and depreciation available, and because the present secondary batteries do not seem to have yet reached a satisfactory commercial form.

The cost of such a plant for coal-gas will vary in this country from $2,500 to $4,000 for each million feet of the yearly make, but $3,000 may be taken as a fair average. Owing to the great variability in the demand for light at different seasons of the year, a gas-works of this size will be called upon to furnish but 200,000,000 instead of 365,000,000 feet a year. The plant will therefore cost $600,000. Of this, $250,000 may be taken as the cost of the mains, which, in average conditions, will have, for a works of this size, a total length of fifty miles, covering a district of about three square miles. To compare an electric with a gas plant, it is necessary to know the number of five-foot burners that will be maintained at the time of greatest consumption, as on this depend both the amount of horse-power required and the size of the mains to transmit the current.

The variation in the demand for light from hour to hour, as it would occur in average conditions on a bright December day, is exhibited in the following table, in percentages of the total make for the twenty-four hours :

7– 8 A. M.	1½ per cent.	7– 8 P. M.	12 per cent.
8– 9 "	½ "	8– 9 "	12 "
9–10 "	½ "	9–10 "	10 "
10–11 "	½ "	10–11 "	6 "
11–12 "	½ "	11–12 "	5 "
12– 1 P. M.	½ "	12– 1 A. M.	1 7/10 "
1– 2 "	½ "	1– 2 "	1 7/10 "
2– 3 "	½ "	2– 3 "	1 7/10 "
3– 4 "	½ "	3– 4 "	1 7/10 "
4– 5 "	7½ "	4– 5 "	1 7/10 "
5– 6 "	16 to 20 "	5– 6 "	1 6/10 "
6– 7 "	14 "	6– 7 "	1 7/10 "

This shows the time of greatest consumption to be between the hours of five and six, and the demand as high as twenty per cent of the entire daily make. In the case of the plant under consideration, the maximum number of burners that will have to be maintained at any one time is therefore 40,000.

Before proceeding to estimate the cost of the plant to generate and distribute electricity sufficient to maintain this number of burners, a few words descriptive of Mr. Edison's system will be desirable, especially as there appears to be considerable misapprehension on the subject. The distribution is what is known as in multiple arc—that is, the lamps are placed upon cross-wires between the conductors. Imagine a ladder erected upon an ordinary railway, so that it stands across the track, each foot resting upon one of the rails. Then these rails will represent the outgoing and returning street-conductors; the side-bars of the ladder, the house-conductors; and each rung, a lamp. The dynamo-machines generating the current are arranged in exactly the same way with regard to the circuit, all the positive poles being joined to one main conductor, and all the negative ones to the other. The arrangement is what is known, in the case of electric batteries, as coupling for quantity, as opposed to coupling for intensity, and is similar to that of a number of pumps discharging water into a common main. This disposition of the electric-producing apparatus has the important advantage that the reserve plant, to meet contingencies, needs to be but a fraction of the total one; while, if each machine supplied an independent circuit, the plant would have to be in duplicate. As is well known, the steam-engines driving the dynamos are coupled directly to the machines, without the intervention of belts or gearing, the combination being termed the steam-dynamo.

The street-mains consist of wrought-iron tubes about two inches in diameter, containing two half-round copper rods imbedded in an insulating resinous cement. A main of this kind is carried continuously around each city block. At the intersections of the streets the conductors are brought together and joined to a main somewhat larger, termed a feeder, which supplies the current to these four blocks. It will thus be seen that the system of mains and the mode of production of the electricity are as readily capable of expansion to meet increased business as in the case of gas. The mains can be tapped anywhere for new consumers, and to meet this increased demand it is only necessary to run a feeder to the place of enlarged consumption, and increase the producing plant sufficiently.

What, then, will be the cost of such an electric plant to do the same amount of lighting as the above gas plant? If we take eight sixteen-candle lamps, maintained throughout the whole system for each actual horse-power applied to the dynamo-machine, engines with a normal capacity of five thousand horse-power will be required to sustain the maximum number of burners. This will include the re-

serve plant, as engines of a normal capacity of forty-two hundred can readily be forced to five thousand horse, or twenty per cent, to meet this extreme demand, and, with the generators arranged after Mr. Edison's plan, this per cent is an ample reserve. The maximum demand can, of course, be met either by forcing, or by running the entire plant at its normal rate, and forcing only in case of accident. To cover a district of three square miles, two distributing stations will be sufficient. The steam-dynamos may be taken as of two hundred horse each, working normally. The present steam-dynamos are of but one hundred and twenty-five horse, but they can be made two hundred horse with but slight increase of cost, which Mr. Edison contemplates doing in future installations. This will give thirteen steam-dynamos to one station and twelve to the other. These may each be placed at $8,000, making a total for the two stations of $200,000. That this is a sufficient allowance will be evident upon considering the machines in detail. There are first the two hundred horse-power engines. No one will question that these can be obtained by a large buyer at $18 per horse-power, or $3,600 each.* This leaves $4,400 to cover the cost of the dynamo. The material in these, as now being constructed, is as follows :

Iron (wrought and cast)	40,700 pounds at	3½ cents =	$1,425	00
Zinc (cast)	680 "	6 " =	40	80
Copper	3,440 "	28 " =	963	20
	44,820		$2,429	00

This leaves $2,071 for the cost of construction, which will be recognized as more than enough, when it is remembered that the cost of the iron as above given includes its shaping, and that the copper on the armature is in the form of bars and disks, which, with suitable tools, can be expeditiously constructed.

Adding twenty-five per cent to the cost of material for the 200-horse machine, there is still left $1,364 to be expended in construction. It seems to me, therefore, that $8,000 is a safe estimate of the cost of such steam-dynamos. Regarding the boilers, the sectional or water-tube boiler, on account of its freedom from dangerous explosions, the smaller space occupied by it, its higher efficiency, and less cost for repairs, is in every way the best suited for a purpose of this kind. Such a boiler set ready for use, including stack and apparatus for handling coal and firing, will cost $20 per horse-power. The total boilers would therefore cost $100,000, making the entire producing portion of the plant, exclusive of real estate, $300,000.

As the Edison mains are now being laid, they will transmit a cur-

* Mr. Edison informs me that engines of 200 indicated horse-power are being purchased by him for $1,750 each, delivered in New York. This estimate is, therefore, much too high, but, as the comparison of plant in the text is based upon it, I have thought it best to let it stand, and point out the needed correction here.

rent sufficient to maintain from sixteen thousand to eighteen thousand sixteen-candle lamps. Taking the former figure, this is one and a quarter mile per 1,000 lamps. Basing the calculation for mains upon this mileage and the size of the present mains, the same number of miles of electric mains would be required as for gas. The present conductors are, as stated, in the form of half-round copper rods, of varying sizes, diminishing of course as they proceed from the station. They are, however, equivalent to round rods with a uniform diameter of one half inch. Such rods weigh $\frac{1886}{10000}$ of a pound per foot, and 3986·4 pounds per mile, costing, at 28 cents per pound, $1,116 per mile. As there are two rods in each main, the cost per mile for copper would be $2,232. To this must be added $1,200 per mile for wrought-iron tube, boxes at the joints between the mains and house-wires, and insulating material, and $1,000 per mile for laying, making the total cost of the main per mile, laid ready for use, $4,432. Four fifths of the mains would be of this size, the other fifth being feeders equivalent to round rods three fourths of an inch in diameter. These latter weigh 1·69 pound per foot, and would therefore cost $2,340 per mile, and, taking the cost of inclosing tube, insulation, and laying the same as above, their total cost per mile would be $7,196. The total cost of the mains, forty miles at $4,432 per mile, and ten miles at $7,196 per mile, would therefore amount to the same as the gas-mains, viz., $250,000. If real estate be added at $50,000, which in most cities requiring this size of plant would be ample, the total cost of the electric plant would be the same as one for gas.*

The elements entering into the cost of the light to the company furnishing it are, in each case, the interest on the investment, depreciation, or the amount spent each year in keeping the property in good condition, the labor of all kinds—in the manufacture, distribution, and management—and lastly the cost of the materials used in its production. In the case of gas but a few of these items as they occur in American works are obtainable, so that recourse must be had to the published reports of foreign companies, and the like items estimated for this country. Of these, the reports of the London companies as analyzed by Mr. Field will best serve for the purpose of the present comparison.† Taking first the item of depreciation, we find that for the four metropolitan companies this was, for the year 1880, on the producing portion of the plant 9·86 cents per 1,000 feet of gas sold, or about five and a half per cent on the cost of this part of the plant as it has been taken in this paper. Calling this ten cents a thousand

* While this estimate seems to me not far from the expenditure that would be actually required for this size of plant, it should be stated that it is lower than any of those given by the electrical experts examined by the select committee of the House of Commons in its consideration of the Electric Lighting Bill.

† Having been unable to obtain a copy of Mr. Field's "Annual," I have taken the figures as quoted from this for the year 1880 by Mr. Dowson, in a recent lecture before the Society of Arts.

feet, we have $20,000 a year as the expenditure under this head, which is probably well within the actual figures of most American works. In the case of the electric plant four per cent is a sufficient allowance for the same item, which gives a yearly charge of $12,000, and a cost of six cents per 1,000 feet.

Depreciation of this part of the plant varies but little with different works, as the conditions upon which it depends are relatively constant, but that of the mains is, on the other hand, exceedingly variable. In a dry, open soil, gas-mains will last a great length of time, and even when they become entirely rusted through they will still continue efficient if undisturbed. They do not, however, remain undisturbed, so that in the most favorable conditions some expenditure is necessary to keep them in working condition. We shall probably not be far wrong if we take this at two per cent of the entire cost of the mains, which includes, of course, that of laying them. This item then becomes in the case of our gas plant $5,000 per year, and 2½ cents per 1,000 feet. In the case of the electric mains, this percentage must be reckoned only upon their cost, exclusive of the copper, as this latter is practically indestructible, and can be used again and again. The amount upon which to reckon the two per cent depreciation is therefore $2,200×50 =$110,000, and the yearly charge $2,200, which gives 1·1 cent per 1,000 feet. The interest on the investment is the same in each case, and amounts to $24,000 a year, at four per cent, and to 12 cents per 1,000 feet. These items include all that are properly chargeable to the expense account of the plant save taxes, which would be about the same in each case, and which may be neglected for the present. The plant account, then, stands, in the two cases, for each thousand feet or its equivalent:

	Gas.	Electricity.
Interest	12·	12·
Depreciation of producing works	10·	6·
" of mains	2·5	1·1
Total	24·5	19·1
	19·1	
Balance in favor of electricity	5·4	

The items entering into the cost of coal-gas are, exclusive of management, rent and taxes, etc., the cost of coal, of manufacturing, and of distribution. Taking the last first, we find 4·4 cents per 1,000 feet as the cost of this item for the four metropolitan companies. Putting this at 5 cents for American works, and deducting from this 2½ cents for the depreciation of mains, which is included in this charge, there is left 2½ cents for the cost of the labor of inspection of meters, etc., which constitutes the charge of distribution, and which would be about the same in both systems.

As the depreciation of the mains is not given separately, this item is liable to error, due to a wrong estimate of such depreciation, but, as it affects both systems similarly, it will not vitiate the results. Under

manufacturing, the English report includes purifying, salaries, the wages for carbonizing, and wear and tear, which latter item has already been carried to the plant account. The first of these amounts to 1·82 cent; the second ·82 of a cent, and the third to 7·16 cents, making a total of 9·8 cents per 1,000 feet. This is probably much below the actual amount paid for these items in American works, but I am assured on excellent authority that, in works constructed after the best modern models, purification should cost the gas company nothing, and that all labor in the manufacturing department should be covered by an outlay equivalent to one man's wages ($2.50 per day) for each 40,000 feet of gas made per day. As the same amount of labor would have to be paid for each day in the year as on the days of greatest demand, this would amount, for a daily make of 1,000,000 feet, to 25 men whose wages at $65 per month ($26\times2\frac{1}{2}$) would be $19,500 * a year, or $9\frac{3}{4}$ cents per 1,000 feet of the actual make. Including the cost of purification, and calling the amount 12 cents, we shall not be far wrong, or at least shall not exceed the actual outlay in the average works of this size. In the case of electricity the labor required at each station would be:

One chief-engineer	$125	per month.
Three assistants (at $75)	225	"
Five firemen (at $60)	300	"
Total	$650	

—making $15,600 a year for the whole manufacturing plant, and 7·8 cents per 1,000 feet. To this may be added $1\frac{1}{2}$ cent to cover salary of electrician and incidental labor, bringing the item up to 9 cents.

There remains to be considered the cost of the coal in the case of gas, and the expense of running the engines in the case of electricity. The cost of coal per 1,000 feet of gas made was, in the case of the London companies, $36\frac{86}{100}$ cents, corresponding to $3.51 per ton, the make of gas being for this amount of coal 9,529 feet. This was offset by the sale of residuals, as below:

Coke and breeze	11·16	cents.
Tar and products	7·18	"
Ammonia and products	5·72	"
Total	24·06	"

—which leaves 12·8 cents as the net cost of the coal.

Compared with foreign companies, both in England and on the Continent, but very little is done with the residual products in this country, and the amounts received vary greatly between different works. Reliable data on this point can not be obtained, but under the most favorable conditions this item can not be taken as amounting to

* The engineer furnishing the information on which this statement is based informs me that this should be $12,500, or $2.50 per 40,000 feet of the actual yearly, instead of the maximum daily, make. This would reduce the item $9\frac{3}{4}$ cents to $6\frac{1}{4}$ cents per 1,000 feet.

more than one half the cost of the coal, while with most works it is probably inconsiderable. The average price of the coal used may be placed at $4.50 a ton, and the amount of gas produced 10,000 feet, making the cost 45 cents per 1,000 feet. This make of gas can hardly be maintained with a production of residuals equal to one half the cost of the coal, but, assuming that it is, the cost of the coal becomes 22½ cents per 1,000 feet.

In the foregoing estimate of the electric plant, it has been assumed that eight lamps could be maintained throughout the entire distributive system for each actual horse-power expended upon the pulley of the dynamo-machine. That this is entirely feasible has been proved by careful tests made by experts in no way interested in any of the lamps, and their results can therefore be accepted without question. For such a use as electric lighting, the cost of a horse-power may safely be taken as not above the best results hitherto obtained in practice. In general manufacturing, the item of power, while important, is not sufficiently so to demand that constant and great care necessary to obtain the very best results, and hence few engines and boilers yield in practice the same results as in special tests. With electric-light companies, this item, on the contrary, is vital, and we may confidently expect to see them in time obtaining their power at a considerably less cost than is now common. Mr. Edison finds as a matter of fact confirmed by several months' test at Menlo Park, that he is able to maintain a horse-power an hour with five pounds of slack (one third pea and two thirds dust), costing $2.45 a ton. For the purpose of the present comparison, however, it is best to make a liberal allowance, and take for a 200-horse-power engine a consumption of four pounds of coal an hour, the coal costing $4.50 per ton of 2,240 pounds, delivered. A horse-power will then cost $\frac{8}{10}$ of a cent an hour, and we may rightly abate our liberality sufficiently to include in this the cost of the oil for lubricating the engine and dynamo.

The maintenance for an hour of 200 electric burners, the equivalent of the 1,000 feet of gas, will therefore cost 20 cents, as against 22½ cents for the gas.

Summing up the results so far obtained, the two accounts stand as follows:

Plant Account.	Per 1,000 Feet. Gas.		Electricity.	
Interest	12·		12·	
Depreciation of producing works	10·		6·	
Depreciation of mains	2·5		1·1	
		24·5		19·1
Manufacturing expenses:				
Labor	12·		9·	
Coal	22·5		20·	
		34·5		29·
Working expenses:				
Distribution		2·5		2·5
Total		61·5		50·6

Under this last heading there should be added rent and taxes, management, law charges, bad debts, and various incidentals. These can not be separately arrived at with any closeness, but they may be taken in the lump as about the same part of the total charges as in the case of the London companies, which is 16 per cent, exclusive of the interest on investment. This in the present case would be 9·4 cents per 1,000, bringing the total cost per 1,000 up to 71 cents with gas and 60 cents with electricity.

The promoters of the electric light would probably demur to this statement, so far as rent and taxes are concerned, as they insist upon the much smaller real estate required with the electric than with a gas plant. This difference does not, however, seem to me sufficient to be of any practical moment, as the real estate in the case of electricity is in the district supplied, where the price of land is relatively high, while the gas companies can readily place their works in such locality as to compensate in lowered land value for the greater amount required. Gas companies can, moreover, build within much smaller limits than usual when for any reason it is desirable, and closely approach the space requisite for an electric installation.

An item of considerable amount which has been omitted from the estimate for electricity is the cost of the renewal of the lamps. With the general introduction of incandescent electric lighting, this is a charge which would fall directly upon the consumer, but it is one which would steadily diminish with improvement in lamps. Assuming, however, that it is a legitimate charge upon the company supplying the light, the item amounts to 10 cents per 1,000, if the lamps have a life of 600* hours and cost 30 cents. This brings the electric account up to 70 cents per 1,000.

So far as coal-gas is concerned, then, these figures show a slight advantage in favor of electricity, and while they are only approximative they are near enough to the truth, I think, to represent the actual relation of the two illuminants. While very much doubtless remains to be done in the improvement of coal-gas manufacture, it does not seem probable that this will affect its cost of production to the same extent as future improvements of electric apparatus may be expected to decrease that of the electric light. Looking closely at the two accounts, it does not seem probable that the item relative to plant will be materially lessened in the future. The cost of the plant has already been taken at a figure very near the lower limit, so near that the substitution of this in its place would make a difference in the yearly plant account of but 2½ cents per 1,000. We may, on the other hand, expect improvements to largely reduce the cost of the electric plant. On Mr. Edison's system of distribution, the size of the conductors varies inversely as the resistance of the lamps, so that they may be

* I am informed by Mr. Edison that the average life of the lamps is now 900 hours, including 3 per cent breakage in handling.

materially reduced if the resistance of these latter can be increased; while any improvements affecting the number of lamps per horse-power diminishes both the interest account by reducing the plant and the actual cost of production.

How far coal-gas can go in a reduction of the cost of production it is difficult to say, but I think the lower limit may safely be taken at the point at which the sale of residuals pays for the coal. Both of these items—cost of coal and prices of residuals—are practically beyond the control of a gas company. The coal is already purchased in the open market at the lowest figures at which it can be obtained, and the market for residuals depends chiefly upon the development of chemical industries, which can hardly be hastened by the action of a gas company. This market is a steadily growing one, and it is not impossible that the residuals will in time pay for the coal, though it is hardly probable. The items of labor and distribution can not probably undergo any considerable reduction. The limit, then, below which it does not appear that there is any probability of coal-gas falling in this country is 46 cents per 1,000, which is a figure that may be reached by electricity without assuming anything less probable than the above supposition respecting gas. It is only necessary to get ten lamps per horse-power, and produce the latter with three pounds of coal an hour, to bring the cost down to 47 cents, exclusive of the lamps.

As a present competitor, however, what is known as water-gas—gas produced by the decomposition of steam in the presence of coal or oil—appears to be the more formidable. This mode of gas-manufacture has the advantage of coal-gas in a lessened cost of the producing plant, a smaller labor account, and a decreased depreciation of the generating apparatus. Its successful competition with coal-gas ultimately depends upon what the latter can make of its residuals, as there is no offset of this kind in its case, but with present conditions it can go below it. The producing portion of the plant costs but little more than half that for coal-gas, while the labor is about a third, and depreciation but slightly more than this. A sixteen-candle gas will require three gallons of oil per 1,000 feet, and can be made with oil at 5 cents a gallon and coal at $4.50 a ton, at an expenditure of 28 cents per 1,000 feet for materials. The total cost will not exceed 60 cents.

Such, then, appears to be the relation of these two agents on the basis of illumination solely, but it must not be forgotten that the amount of light which each plant can furnish does not represent the actual relative capacity of the two. The electric plant can be run not only four hours a day for light, but any further number of hours for power, without any increase of the machines. The gas-plant, on the other hand, would have to be increased, to furnish both power and light. That this advantage of electricity is liable to be a very important one will hardly be questioned, when the extent of the field open to electro-motors is borne in mind.

On these figures the cost of electricity is near enough to that of gas to enable it to offer a very substantial competition, and one which may be expected to grow stronger with increased experience and future improvements. That under the stimulus of this competition considerable improvement will be made in lighting by gas seems very probable. Already it has been shown that in the matter of burners there is a wide field for invention, and that the results now usually obtained are much under what are possible. With the high-power burners of Siemens, the illumination obtained from sixteen-candle gas has been more than doubled, and in others it has been carried up to from five to five and a half candles per foot. How suitable burners yielding such a great increase of light will be for the general purposes of lighting, and whether they can with advantage displace the simple flat tip, remains to be seen, but the present indications are that it is chiefly through the use of improved burners that gas must endeavor to resist the assaults of the incandescent light. Competition on the basis of a gas of higher illuminating power simply, without a resort to improved burners, does not seem very promising. The recently published report of the sub-commission appointed to test the incandescent lamps at the Paris Exhibition, of which Mr. Crookes was a member, shows that a thirty-two-candle lamp can be maintained with an increase of from 28 to 37 per cent of the power required to sustain one of sixteen candles, while with gas such an increase of illumination will require an additional expense of fully 50 per cent of the cost of one of the lower candle-power. This is so with the Lowe gas, with which three gallons of oil are sufficient to give sixteen candles, but six are required for thirty-two, and it is not probable that coal-gas can be enriched any cheaper. Whether the limit to progress in gas-lighting—both in the matter of improvement of manufacture and burners—is sufficiently far off to give gas unquestioned possession of the field of lighting or not, the result can alone determine. But, if the figures presented in this paper can be at all relied upon, they show that gas-manufacturers and those interested in gas property will do well not to underrate the strength in their own domain of this rising industrial power.

LONGEVITY.

By FELIX L. OSWALD, M. D.

DURING his last expedition to Central Asia, Professor Vambéry managed to interview the Emir of Samarcand—a sort of Mohammedan prince-cardinal and primate of the Eastern Sunnites. As Imam of the local lyceum the Emir appeared to take a natural interest in the progress of European science, but, when his guest expatiated on

the material prosperity of the Western Giaours, he interrupted him with a less expected question.

"The happiest people on earth, you call them? What age do they generally attain to?" Vambéry seems to have returned an evasive reply, though he admits that the query was not altogether irrelevant, at least from the stand-point of an Oriental who values existence for its own sake. But, even in the less unpretending West, longevity is not a bad criterion of happiness. Misfortune kills; Nature takes care to shorten a life of misery—for reasons of her own, too, for, in a somewhat recondite (but here essential) sense, the survival of the happiest is also the survival of the fittest. The progress of knowledge tends to circumscribe the realm of accident, and with it the belief in the existence of unmerited evils. In spite of prenatal influences and unprecalculable mishaps, the management of the individual is the most important factor in the sum total of weal or woe. If we could see ourselves as Omniscience sees us, we would probably recognize our worst troubles as the work of our own hands, and we thus recognize them now with sufficient clearness to be half ashamed of them. Most men nowadays dislike to confess their bad luck. We have ceased to ascribe diseases to the malice of capricious demons, and even in Spain the commander of a beaten army would hesitate to plead astrological excuses. Polycrates held that a plucky man can bias the stars, and the popular worship of success may be founded on an instinctive perception of a similar truth. Sultan Achmed went too far in his habit of strangling his defeated pashas, but the world in general agrees with him that there must be something wrong about a generally unsuccessful man. After two or three decided defeats the partisans of a popular leader will give him up for lost, and after a series of disasters the damaged man himself generally begins to share their opinion and loses heart, or, as the ancients expressed it, admits the decree of fate—i. e., his own inability to prevail in the struggle for existence; and it is curious how swiftly a physical collapse often follows upon such a giving way of the moral supports. The storms of every political, social, and financial crisis extinguish hundreds of life-flames; lost hope is a fatal (though a silent and sometimes an unconfessed and unsuspected) disease. Good luck, on the other hand, tends to prolong life; the longevity of pensioners and sinecurists is almost proverbial, and there are men who continue to live in defiance of all biological probabilities, merely because existence somehow or other has become desirable, as a liberal supply of external oxygen will nourish a lamp in default of the inner oil. At the beginning of the Franco-Prussian War, King William and his chancellor and staff-officers were already gray-headed veterans, and it is no accident that they are all alive yet; while nearly all the ministers and marshals of the exploded empire have followed their leader—"weary of life and tired of buttoning and unbuttoning," as a captain of H. M. S. explained his suicide.

The votes that killed Cavour and Disraeli probably revived La Marmora and Gladstone. Success is a panacea; a series of long-lived rulers will generally be found to coincide with an era of national triumphs, and a general increase of longevity with a period of material progress, industrial development, good crops, etc., for, when "living" is cheap, one man's success does not necessarily imply the short-coming of his neighbor.

But, as Ludwig Börne says, "to be happy is one of the cardinal virtues"—there is such a thing as a gift of supporting vitality on an accident-proof fund of good humor, a Mark-Tapley-like disposition to exult in the disregard, or, at least, in the defiance, of bad-luck. In stress of circumstances, Hamlet's alternative may often depend upon the possession of this accomplishment, for I believe that it is one of the talents which can be cultivated. Not all men can attain to the philosophical eminence of Francis Fénelon, who valued gloomy days as a foil to brighter ones; but a step in the right direction is a resolute contempt of trifling adversities, which leads to the habit of distinguishing life from its incidents, the pilgrimage from the way-side vicissitudes, and can be most easily acquired by keeping an ultimate goal in view—not a supramundane one necessarily, but something elevated enough to aid us in overlooking the base annoyances which beset all but the loneliest by-ways of modern life. This devotion to a nobler and enduring, or even a permanently interesting, object—a mere hobby, in fact—serves to enhance the value of life, and explains the success of many survivors under apparently hopeless difficulties, the victory of competitors handicapped with disease, poverty, and deficient education; they support a cause which supports them in return; they live upon as well as for a principle. Hence the apparent paradox of the longevity of busybodies, of men who seem to burn the fuel of life at an extravagant rate. Xenophon, Cardinal Richelieu, Ximenes, Benjamin Franklin, and Frederick the Great, were probably the busiest men of their respective nations, gallop-riders on a road where others kept the even tenor of their way, but they bestrode their hobbies and managed both to outride and outlive their competitors.

It is, indeed, a mistake to suppose that the tranquillity, *per se*, of a man's life tends to prolong its duration; and the longevity of stagnant villages and country parsons proves only how infinitely *health* outweighs all other means of happiness. The peasants of Southern Russia live almost as frugally as the Hebrew patriarchs, on milk, bread, and honey, with a bit of cheese now and then, or a drop of hydromel (half-fermented honey-water); their climate is dry and favorable to perennial out-door life, and in spite of official tyranny, war, and rumors of war, feudalism, and outrageous over-taxation, they outlive the free-born British yeoman, with his strong ales and daily beefsteaks. But the coincidence of dietetic and administrative abuses cuts the thread of life with a two-edged knife, and in Northern Russia the average

duration of life is ten years less than among the equally intemperate but less misgoverned natives of Northern Germany, and almost twenty years less than in the equally despotic but less poison-cursed territories of the Shah.

Historically, too, the lowest ebb of human happiness coincides with that of human longevity. The ancient Greeks outlived us by about thirty years, but even our northern Russians would outlive the nations of the Christian middle ages, when common sense was a capital crime, the suppression of all natural instincts the chief aim of education, and the invention of new instruments of torture the only flourishing branch of industry. The Western pessimists dislike to confess the main object of their religion; but their first exemplar, Buddha Nepaulensis, did not hesitate to define it as the mortification of all earthly desires—in other words, the shortening of life by all possible means, excepting the resort to the summary and, therefore, more desirable methods of direct suicide.

The depreciation of Nature, which formed the constant theme of the orthodox preachers, may have had something to do with the unparalleled destructiveness of mediæval epidemics; if life was a curse and death the highest gain, the converts of such dogmas must have yielded to Siva with Hindoo-like apathy, while, on the other hand, it is a well-established fact that the mere determination to live has often turned the scales in the crisis of an apparently hopeless disease. During the Grecian Revolution of 1821, Edward Trelawney survived a load of buckshot because he "felt that he had no right to die," and mothers with a houseful of sick children have frequently resisted the virus of a contagious fever. Mahmed Kasim, the first Arabian conqueror of Hindostan, was infected with the pest by the messenger of a rajah who had adopted that method of freeing his country from the invaders, and, in spite of all remedies, a number of Mahmed's companions died before the end of the week. But Mahmed himself "conquered the disease as he had conquered the rajahs"—recovered by sheer will-force, and continued the campaign on the seventh day after the arrival of the plague-bearer.

In the century of Trajan, the Thessalian mountaineers were the macrobiotes, the long-livers, *par excellence*, of the Roman Empire; the natives of Asia Minor, with her over-populated islands and luxurious cities, the most short-lived. Time has since wrought strange changes in the land of the Ephesians; the wealthy cities have disappeared, and, with the single exception of her North-Persian neighbors, the Levanters are now the longest-lived race on earth. Next come the Turks, Greeks, Arabs, Hindoos, and southern Russians; next to these, and long before any West Europeans, the present inhabitants of the United States, for the advantages of a golden age like ours more than counteract such things as pork-fritters and strawberry-shortcakes. Among the separate States, North Carolina and Vermont hold the highest rank; Louisiana and New Jersey the lowest, topographi-

cally as well as biologically. As a rule, highlanders outlive their lowland neighbors, country people the city folks, and among the cities of the Caucasian nations sea-port towns without swamps are the most salubrious. New York is the healthiest large city in America; St. Petersburg, in spite of her high latitude, the unhealthiest of all cities whatever, taking the longevity of the natives as a criterion, for the inclusion of foreign residents would give the highest death-rate to Singapore or Vera Cruz. The Neva swamps breed fever and rheumatism, diphtheria and consumption, turn about, and in co-operation with the marasmus of bureaucracy and political espionage. But what makes Munich such a peculiarly unhealthy place? It must be lager-beer, or else the tedium of Bavarian orthodoxy and Wagner's operas—the mania of the past combined with the "music of the future"—for under the same latitude merry Paris reconciles fast-living with long-living enough to yield to no first-class city except New York. The burghers of Vienna shorten their lives with greasy made-dishes, and the Berliners with fell schnapps and a still fiercer struggle for existence—twelve hundred thousand eupeptic bipeds, surrounded by sand-hills, and living on their wits and on each other.

London holds about the medium between New York and St. Petersburg, but should not be mentioned in the same class with other towns, since her populace has expanded into a nation, distributed over fifteen or sixteen towns and half a hundred villages. The business part of the great brick wilderness, divested of its oases and outlying garden regions, would probably prove to be the richest harvest-field of Death, for coal-smoke and red-hot competition are unfavorable to longevity, and the *mens æqua in arduis* has ceased to be an Anglo-Saxon characteristic.

The cities of Italy, Spain, and Portugal have become parasites upon the starving country population; strongholds of pampered priests and titled sinecurists; but, with all his freedom from worldly cares, the *gordo sanducho*, the clerical glutton, is outlived by the rustic pariah, as a proof that the favor of Nature is better than the favor of princes:

> "How small the part that laws can cause or cure,
> Of all the ills that human hearts endure!"

—and human bodies, too; the tax-collector, with his thumb-screws, calls around once a year, but the gout every week, and dyspepsia once or twice a day. Turks and Italians inhabit the same latitude, and nearly the same kind of mountains and semitropical plains, and the remarkable physical inferiority of the Trinitarians must be ascribed to their stimulating diet and greater sensuality, for somehow or other the rustic Mussulman is a truer monogamist than his Western neighbor. In the time of Strabo the Island of Cos was noted for the general health of its inhabitants and their longevity, which some Grecian physicians attributed to the excellence of the drinking-water, and others

to the genius of Hippocrates, who had taken the islanders under his special protection. That genius must have settled in the Turkish town of Janina, where drug-stores are unknown, and indeed superfluous, as a sick person is at once suspected of wine-drinking, and takes care to conceal his condition. The town is situated at the head of a clear mountain-lake, and the longevity of the abstinent inhabitants might tempt an undertaker to indulge in the remark of Frederick the Great, at the battle of Kolin, when his grenadiers finally refused to advance: "*Ihr Hunde, wollt Ihr ewig leben?*"—(Ye hounds, are ye going to live for ever?)

Frugality, in the sense of vegetarianism, is the sometimes involuntary virtue of most Orientals, and may help neutralize their narcotics; the flesh-abhorring Hindoos attain to a surprising age, considering their *penchant* for betel-poison and their ultra-Arabian poverty. Our carnivorous red-skins are the most short-lived of all outdoor dwellers, and clearly in consequence of their diet, for in South America, too, even the inhabitants of the malarious sea-port towns survive the *gauchos*, whose *menu* is limited to three courses and one *entremet*—dried beef, fresh beef, salted beef, and beef-tallow.

Professor Schrodt, who includes horse-riding among the sedentary occupations, recommends pedestrianism as a cure for all possible diseases, since the German *Land-boten*—mail-carriers afoot—generally attain to an extreme old age, and appeals to several Grecian writers who make a similar remark in regard to the Spartan *hemerodromes*. In Prussia all government employés are pensioned after a certain term of service, and a *Land-bote* enjoys, therefore, the advantage of an insured income in conjunction with the necessity of physical exercise—bodily motion combined with ease of mind—the health-secret of the gymnosophists and the children of the wilderness.

"Woe to them that are at ease!" says Carlyle, but his anathema does not prevent the English village parson from outliving every other class of his countrymen, not excepting the British farmer, whose peace of mind can not always be reconciled with high rents and the low price of American wheat. Where agriculture is what it should be—a contract between man and Nature, in the United States, in Australia, and in some parts of Switzerland—the plow-furrow is the straightest road to longevity; in Canada, where Nature is rather a hard taskmaster, the probabilities are in favor of such half-indoor trades as carpentering and certain branches of horticulture—summer farming, as the Germans call it. Cold is an antiseptic, and the best febrifuge, but by no means a panacea, and the warmest climate on earth is out and out preferable even to the border-lands of the polar zone. The average Arab outlives the average Esquimau by twenty-five years.

The hygienic benefit of sea-voyages, too, has been amazingly exaggerated. Seafaring is not conducive to longevity; the advantage of the exercise in the rigging is more than outweighed by the effluvia

of the cockpit, by the pickle-diet, the unnatural motion, and the foul-weather misery; and, from a sanitary stand-point, the sea-air itself is hardly preferable to mountain and woodland air. The eozoön may have been a marine product, but our Pliocene ancestor was probably a forest creature.

"For what length of time would you undertake to warrant the health of a seaman?" Varnhagen asked a Dutch marine doctor. "That depends on the length of his furlough," replied the frank Hollander, and it will require centuries of reform to redeem our cities from the odium of a similar reproach. In victuals and vitality towns consume the hoarded stores of the country, and only the garden-suburbs of a few North American cities are hygienically self-supporting. Permanent in-door work is slow suicide, and between the various shop-trades and sedentary occupations the difference in this respect is only one of degree. Factories stand at the bottom of the scale, and the dust and vapor generating ones below zero; the weaver's chances to reach the average age of his species have to be expressed by a negative quantity. In France, where the tabulation of comparative statistics is carried further than anywhere else, the healthfulness of the principal town trades has been ascertained to decrease in the following order: House-building, huckstering, hot-bed gardening (florists), carpenter and brick-mason trades, street-paving, street-cleaning, sewer-cleaning, blacksmiths, artisan-smiths (silver, copper, and tin concerns), shoemaking, paper-making, glass-blowing, tailor, butcher, house-painter, baker, cook, stone-masons and lapidaries, operatives of paint and lead factories, weavers, steel-grinders—the wide difference between brick and stone masons being due to the lung-infesting dust of lapidary work, which, though an out-door occupation, is nearly as unhealthy as steel-grinding. Lead-paint makers have to alternate their work with jobs in the tin-shop, and, after all, can rarely stand it for more than fifteen years; needle-grinders generally succumb after twelve or fourteen years. The human lungs seem able to eliminate the impurities breathed by street and sewer cleaners, for, in London as well as in Paris and Marseilles, the followers of both trades rank high among the long-lived classes. Hucksters somehow manage to outlive city gardeners as well as shopkeepers; among the Hecubas of the Paris market-hall, not less than two hundred and eighteen had passed their threescore and tenth year.

Preaching, and, strange to say, pettifogging, are the healthiest of all the learned professions; their lung-exercise may have something to do with it, for lecturing-teachers outlive the "silent" teachers (dancing-masters, etc.). Physicians die early; Nature revenges herself upon her leagued adversaries, for druggists and barbers (in many parts of Europe synonymous with village quacks) are likewise short-lived; but sextons reach a good old age: there must be a mistake about the supposed danger of grave-yard effluvia.

Art still increases the value of human life, but not its length; the greatest modern masters of tune and color died in their prime, like the greatest poets; inspiration, in all its forms, would seem to be a flame that consumes the human clay more quickly than the fire of affliction —if the extreme longevity of so many of the ancient masters did not suggest a different explanation, namely, that the revelations of Nature and the tendencies of established dogmas have ceased to harmonize, and that the lovers of truth have nowadays to cross a Pontus where they must prevail against a whole sea of adverse currents, or Leander-like perish.

In the course of the last sixty or seventy years the average duration of human life has undoubtedly increased in all civilized countries, but it is not less certain that the gain of a few decades does not yet begin to offset the loss of centuries; we have saved ourselves from the abyss of mediæval unnaturalism, but we are still far from having recovered the ancient heights of vitality; the after-effects of the Buddha-poison still cramp our limbs and sadly retard our upward progress; but the tide has turned, and the main currents of the age have ceased to set deathward.

According to the demonstrations of the naturalist Camper, the normal average of our life-term should be at least ninety years. His arguments are both biological and historical, and would agree with the scriptural records, if, as Schleiermacher suggests, the Genesis-years were *seasons*, of about ninety days. The "years" of the patriarchs were certainly not *months*, for men who saw their children and children's children must have lived longer than thirty years The biological argument that in a state of nature the life of a mammal relates to the period of its growth as 6–8 to 1, would give us an average of 90–160; the southern Arab is full-grown with sixteen years, the northern Caucasian hardly before twenty. Hundreds of ancient statesmen and philosophers outlived their threescore and ten by a full decade, though we need not doubt that then, as now, metaphysics and politics were not specially conducive to longevity, nor that even by that time vices had shortened the natural average by several decades.

But there is another *a priori* argument which, from all but an ultra-pessimistic stand-point, seems almost self-sufficient in its conclusiveness. The whereabouts of new planets have been discovered by an inductive process based upon the observation of otherwise unaccountable disturbances in the orbits of other stars, and Camper's theory alone would account for an otherwise inexplicable contradiction in the economy of human life. Man's life is too short for the attainment of its highest purposes. Our season ends before its seed has time to yield a harvest; before a brave day's work is half done we are overtaken by the night, when no man can work. As the world is constituted, it takes a certain number of years for a new industry to take root and yield its first fruits; it requires a certain period for a new opinion to

penetrate the crust of society and reach the fertile subsoil of the lower strata. Before the end of that period the planter of the tree has to fertilize the soil with his own bones ; the weary tiller has to yield his plow to other hands. And the noblest plants are of such slow growth that the master of the vineyard appears to discriminate against his worthiest laborers ; nothing seems wanting to aggravate the injustice and incongruity of the existing arrangement.

But a minimum life-term of ninety years would reconcile all contradictions : two thirds of it would be enough for the adjudication of every claim, and the remaining third could be devoted to rewards or retributions. The second generation, which now can only reverse and regret the short-sighted judgment of the first, would have a chance to make amends for the injustice. Such men as Kepler, Spinoza, Dante, Milton, Bayle, Rousseau, Mirabeau, Burns, Beethoven, Paine, and Byron, would have survived the influence of their detractors, and Time, the avenger, could have answered their appeal with something better than a monument.

ANIMAL SELF-DEFENSE.

By H. L. FAIRCHILD.

A FIERCE and pitiless struggle for life in the animal world is a stern fact. All creatures are beset by dangers. The negative conditions of cold and hunger and the positive influences of nature's elements are more easily resisted than the innumerable voracious foes. Every animal is predestined food for some other animal. But self-preservation is a universal thought, and endless is the variety of ways whereby life is prolonged.

A few external organs of defense are familiar to every one—as horns, claws, teeth, stings, shells, etc. Many animals depend on weapons and muscular power, a still greater number upon keen senses and fleetness—eternal vigilance. Others rely upon intelligence, cunning, simulation, and deceit ; while stupidity, against which even the gods are powerless, may be the saving of others. Some are protected by skill in construction, some by unconscious resemblance, and a host by color, armor, and other passive means. A volume would not exhaust the subject, as there is scarcely a species of animal without some peculiarity for self-preservation.

This brief paper will only treat of defense against enemies ; and, although the subject permits of no natural classification, an arbitrary division into passive and active defense will be convenient.

A host of animals of all classes and ranks are more or less defended by a hard covering—the result of natural growth. Such defense, like other modes to be described, is strictly involuntary and passive ; and,

requiring no intelligent effort, it may be regarded as the lowest. But even in this there is unbounded variety. We will distinguish the following classes :

1. *Transformed epidermis* constitutes the armor of the lobster, insects, and hard-skinned articulates in general. Also the hair of mammals, the feathers of birds, the scales which cover most fishes, reptiles, and the legs of birds, and the plates of that lizard-like mammal, the

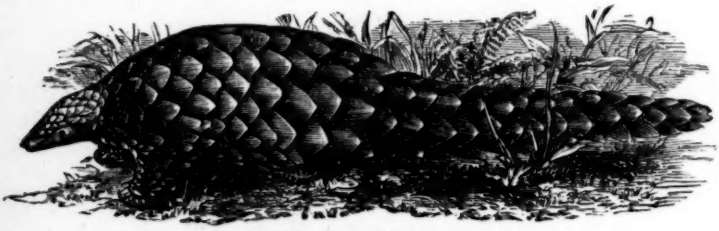

FIG. 1.—MANIS (*Manis pentadactyla*).

manis. 2. *Stony secretion* of the skin. Here belong the limy shells of mollusks, the tests of sea-urchins, star-fishes, etc. ; also those of the chalk-forming rhizopods, and the silica shells of other microscopic animals. 3. True *bony armor* produced by the skin ; as the coat-of-mail of the armadillo, and the scale-armor of the ganoid fishes, the bony pike and sturgeon, for example (also the armor of the group to which

FIG. 2.—STURGEON (*Acipenser*).

belong the trunk-fishes. This sort of armor was very common among the most ancient fishes, but it has now gone quite out of fashion. The crocodile and alligator still have this bone armor in great perfection, and covered with epidermic plates—that is, they have a combination of 1 and 3. Altogether they are as well protected as any

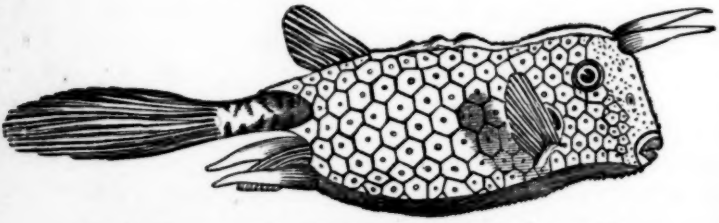

FIG. 3.—OSTRACIONTIDÆ. Horned Trunk-fish (*Ostracion cornutus*).

living creature. The armadillo has only its back covered with this bone armor, but, like the hedgehog and the manis, it can roll itself into a ball with the unprotected parts inside. 4. In the turtles the

endo- or *vertebra-skeleton*, is strangely modified and partly expanded upon the outside of the body ; so it is literally true that the turtle is inside of his internal skeleton. The ribs are expanded to form the carapax, and the breast-bones to form the plastron of a solid box, within which many species can withdraw their head and limbs. But this is not all. The box is completed by the addition of numerous bony plates developed from the skin, and over all a horny epidermic

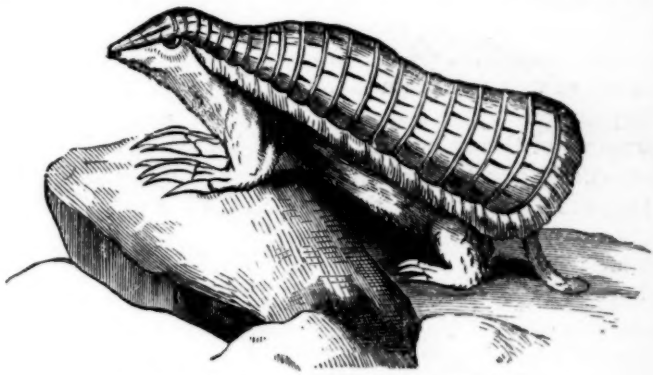

FIG. 4.—ARMADILLO (*Chlamyphorus truncatus*).

covering. The latter furnishes the beautiful and valuable tortoise-shell. Thus the armor of a turtle is a combination of 1, 3, and 4. One of the land-tortoises, the box-tortoise, deserves particular mention. The plastron, or breast-plate, of this species is divided into two movable parts hinged at a line drawn transversely or across the middle. When its head and feet are withdrawn, each end of the shell is tightly closed, so that no animal can get even a claw inside.

The skin of the rhinoceros is so very tough and thick that it defies ordinary weapons, and is said to resist soft-lead rifle-bullets.

Spines may be either (1) *epidermic* or (2) a *secretion*. The first class includes the spines of the echidna, hedgehog, and porcupine ; also those of most fishes, lizards, and crabs. To the second class belong those of the globe-fishes, mollusks, rhizopods, and sea-urchins. The spines of the latter group have a remarkable structure. They are attached to the test or shell by a ball-and-socket joint and each moved by independent sets of muscles. While some species have only a very few large club-shaped spines, others have countless thousands of minute needles. The thorn-like spines of the common sea-urchin are also used in locomotion, and it has been happily said that a sea-urchin on its travels is like an animated chestnut-bur.

The hedgehog is one of the best protected of living animals. "Marching securely under the guardianship of its thorn-spiked armor, it recks little of any foe save man. . . . The formidable array of bristling spines with which the back is more or less covered offers a

cheval-de-frise of sharp spikes toward any animal that may present itself as an enemy. Another peculiarity is the power possessed by these creatures of rolling themselves into a round ball, by placing the head on the breast, drawing up the legs, and curling the body firmly round the members. By this posture the hedgehogs render themselves invulnerable to almost any animal that may attack them. . . . When in this curious attitude, the hedgehog can not be unrolled by main force, as long as any life remains in the body, for there is an enormously developed muscle, with a very thick margin, which spreads over the back and round the sides, and which, when contracted, holds the creature in so firm an embrace that it will be torn in pieces rather than yield its point."

The spines of this animal are about an inch long, and naturally lie flat on the back, directed toward the tail. But by a peculiar arrangement they are erected when the owner coils himself. In shape the spine "is not unlike a large pin, being sharply pointed at one extremity, and furnished at the other with a round, bead-like head, and rather abruptly bent near the head. If the skin be removed from the hedgehog, the quills are seen to be pinned, as it were, through the skin, being retained by their round heads, which are acted upon by the peculiar muscle which has already been mentioned.

"Protected by this defense, the hedgehog is enabled to throw itself from considerable heights, to curl itself into a ball as it descends, and to reach the ground without suffering any harm from its fall. A hedgehog has been seen repeatedly to throw itself from a wall some twelve or fourteen feet in height, and to fall upon the hard ground without appearing to be even inconvenienced by its tumble. On reaching the ground, it would unroll itself and trot off with perfect unconcern."

The quills upon the "fretful porcupine" are several inches in length. The absurd belief that this animal could throw its quills at an enemy, after the fashion of a lance, arose from the following facts: "Their hold on the skin is very slight, so that, when they have been struck into a foe, they remain fixed in the wound, and, unless immediately removed, work sad woe to the sufferer. For the quill is so constructed that it gradually bores its way into the flesh, burrowing deeper at every movement, and sometimes even causing the death of the wounded creature. In Africa and India leopards and tigers have frequently been killed in whose flesh were pieces of porcupine-quills, that had penetrated deeply into the body, and had even caused suppuration to take place. In one instance a tiger was found to have his paws, ears, and head filled with the spines of a porcupine which he had vainly been endeavoring to kill. . . . If irritated or wounded, the porcupine becomes at once a very unpleasant antagonist, as it spreads out its bristles widely, and rapidly backs upon its opponent."

Many small creatures are undoubtedly protected by *offensive fluids*

or *odors*, which are not a matter of consciousness or will. In illustration of this method of defense, it will be sufficient to quote the following: "In South America there is a family of butterflies termed *Heliconidæ*, which are very conspicuously colored and slow in flight, and yet the individuals abound in prodigious numbers, and take no precautions to conceal themselves, even when at rest during the night. Mr. Bates found that these conspicuous butterflies had a very strong and disagreeable odor; so much so, that any one handling them, and squeezing them as a collector must do, has his fingers stained and so infected by the smell as to require time and much trouble to remove it. It is suggested that this unpleasant quality is the cause of the abundance of the *Heliconidæ;* Mr. Bates and other observers reporting that they have never seen them attacked by the birds, reptiles, or insects, which prey upon other lepidoptera."

Great numbers of animals are permanently colored so as to harmonize with their favorite surroundings. This *obscure coloring* may be either for the purpose of securing prey, or for concealment. The banded colors of the tiger perfectly blend with the lights and shadows in the jungle-grass. Those forest animals which live on the ground, as game-birds, deer, rabbit, or squirrel, are of brown or neutral hues, which assimilate to the color of dead leaves and tree-trunks; and they are quite impossible to discover as long as they remain motionless. Animals of the desert are dull or rust colored, or of some light tint. Insects, frogs, and lizards, which live among the leaves, are green; those on the ground in dry or rocky places are pale accordingly. Grasshoppers generally have the prevailing hue of the fields where they subsist. Indeed, protective coloration is very common, and any person can find examples.

More remarkable, however, is the protection afforded by what is termed *chromatic function*. "It consists in the power possessed by many fishes, crustaceans, amphibia, and reptiles, of adapting their general coloring, often by extremely rapid alteration, to the coloring of the surrounding objects, so that they seem to be helped by it in the pursuit of their prey, or especially protected against the attacks of their enemies."

This is very striking in many fishes. It can be readily observed in the common tree-frogs. The chameleon and the devil-fishes are famous for their power of changing color when irritated. The degree of consciousness involved in this is unknown.

The *resemblance to inanimate objects* of many small animals, especially insects, is one of the most curious things commonly met with. Insects imitate leaves, sticks, dry twigs, stones, lichens, etc., so perfectly as to sometimes deceive the close observer. The most remarkable examples are found in the tropics, where insect-life luxuriates. Wallace thus describes an Indian butterfly (*Kallima*): "The upper surface of these is very striking and showy, as they are of large size,

and are adorned with a broad band of rich orange on a deep-bluish ground. The under side is very variable in color, so that out of fifty specimens no two can be found exactly alike; but every one of them will be some shade of ash, or brown, or ochre, such as are found among dead, dry, or decaying leaves. The apex of the upper wings is produced into an acute point, a very common form in the leaves of tropical shrubs and trees, and the lower wings are also produced into a

FIG. 5.—LEAF-BUTTERFLY (*Kallima paralekta*).

short, narrow tail. Between these two points runs a dark curved line exactly representing the midrib of a leaf, and from this radiate on each side a few oblique lines, which serve to indicate the lateral veins of a leaf. . . . But this resemblance, close as it is, would be of little use if the habits of the insect did not accord with it. If the butterfly sat upon leaves or upon flowers, or opened its wings so as to expose the upper surface, or exposed and moved its head and antennæ as many butterflies do, its disguise would be of little avail. We might be sure,

however, from the analogy of many other cases, that the habits of the insect are such as still further to aid its deceptive garb; but we are not obliged to make any such supposition, since I myself had the good fortune to observe scores of *Kallima paralekta*, in Sumatra, and to capture many of them, and can vouch for the accuracy of the following details: These butterflies frequent dry forests and fly very swiftly. They were never seen to settle on a flower or a green leaf, but were many times lost sight of in a bush or tree of dead leaves. On such occasions they were generally searched for in vain, for, while gazing intently at the very spot where one had disappeared, it would suddenly dart out, and again vanish twenty or fifty yards farther on; on one or two occasions the insect was detected reposing, and it could then be seen how completely it assimilates itself to the surrounding leaves. It sits on a nearly upright twig, the wings fitting closely back to back, concealing the antennæ and head, which are drawn up between their bases. The little tails of the hind wing touch the branch, and form a perfect stalk to the leaf, which is supported in its place by the claws of the middle pair of feet, which are slender and inconspicuous. The irregular outline of the wings gives exactly the perspective effect of a shriveled leaf. We have thus size, color, form, markings, and habits, all combining together to produce a disguise which may be said to be absolutely perfect; and the protection which it affords is sufficiently indicated by the abundance of the individuals which possess it."

Of the walking-stick insects Wallace says: "Some of these are a foot long and as thick as one's finger, and their whole coloring, form, rugosity, and the arrangement of the head, legs, and antennæ, are such as to render them absolutely identical in appearance with dry sticks. They hang loosely about shrubs in the forest, and have the extraordinary habit of stretching out their legs unsymmetrically, so as to render the deception more complete." The counterfeiting is carried even to the imperfections and injuries of the objects copied. Still speaking of the walking-stick insects, Wallace says: "One of these creatures, obtained by myself in Borneo, was covered over with foliaceous excrescences of a clear olive-green color, so as exactly to resemble a stick grown over by a creeping moss or jungermannia. The Dyak who brought it assured me it was grown over with moss, although alive; and it was only after a

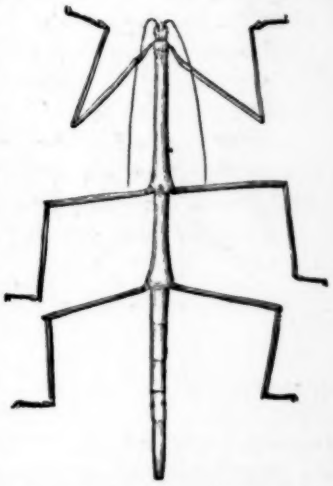

FIG. 6.—*Phasma* sp., a wingless orthopterous insect.

most minute examination that I could convince myself it was not so." And of a leaf-butterfly he says: "We find representations of leaves in every stage of decay, variously blotched and mildewed, and pierced with holes, and in many cases irregularly covered with powdery black dots, gathered into patches and spots, so closely resembling the various kinds of minute fungi that grow on dead leaves that it is impossible to avoid thinking at first sight that the butterflies themselves have been attacked by real fungi."

Mimicry is the resemblance which poorly protected animals bear to others well protected. Several species of edible butterflies imitate the *Heliconidæ* and others, which are protected by fetid odors; other

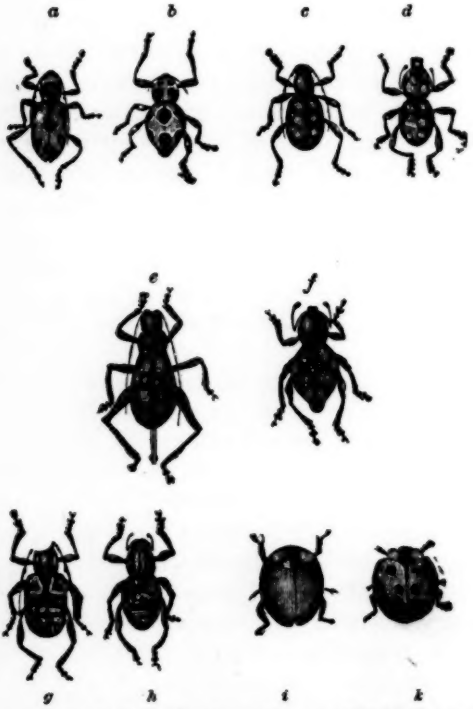

FIG. 7.—*a*, *Dolíops* sp., mimics *b*, *Pachyrhynchus orbifer*; *c*, *Dolíops curculionoides*, mimics *d*, *Pachyrhynchus* sp.; *e*, *Scepastus pachyrhynchoides* (a grasshopper), mimics *f*, *Apocyrtus*; *g*, *Dolíops* sp., mimics *h*, *Pachyrhynchus* sp.; *i*, *Phoraspis* sp. (a grasshopper), mimics *k*, a *Coccinella*. All from the Philippines, of natural size. It is evident that the great similarity of the creatures to those they mimic is less conspicuous in the engraving than in real life, since the exact correspondence in the coloring can not be given here.

butterflies mimic wasps so closely that persons fear to handle them, although the imitation does not extend to the sting. Innocent beetles imitate other beetles which have hard shells or fetid glands. They also mimic bees and wasps. Flies also mimic wasps, and grasshoppers mimic beetles. Some moths almost exactly imitate the form and color of humming-birds. Wallace states that some harmless snakes

mimic poisonous species. And this mimicry is found even among birds.

Active defense implies such organs and methods of defense as are under control of the animal's will, or matters of conscious action. We shall here find much greater variety.

The homes of animals—nests, houses, burrows, etc.—are protection from the storm and for the young as well as from foes. This is a most interesting and extended field, and requires separate treatment.

But many small creatures build individual *shells* or *cases* wholly for defense against enemies. These are frequently carried about with the creature, as armor, wherever it goes. A familiar example, found in any brooklet, is seen in the case of the young caddis-fly. To hide and protect itself from the ever-hungry fishes, the larva of this insect incloses its body in a tube formed by gluing together bits of wood, shells, sand, and all sorts of matter that may be found at the bottom of a stream. This case has a silken lining, and out of the end the larva protrudes its head and legs for locomotion, or wholly withdraws out of sight and danger. Other water larvæ reside within a bit of hollow straw or plant-stem. A similar habit characterizes a group of sea-worms, to which belongs the *Serpula*. Thin tubes may be formed of a limy secretion, or built by cementing sand, shells, etc. One of the tentacles of the *Serpula* is terminated by an expansion which, when the worm withdraws into its case, serves as a stopper (operculum) to securely close the opening (see Monthly, February, 1882, page 452, Fig. 4). The silk *pupa-cases* of the moths are very wonderful, even if very common, examples of artificial covering.

FIG. 8.—CADDIS-WORM, WITH ITS CASE.

The singular hermit-crabs are obliged, on account of their lack of a hard epidermis, to inhabit some empty mollusk-shell. And they are exactly fitted for that sort of life : the tail-fin is changed into hooks for holding the shell ; some of the legs are strong levers for dragging its heavy house ; and one of its claws is disproportionately large, in order to close the opening of the shell.

Keen senses combined with *swiftness of locomotion* are the chief reliance of birds and mammals. The rabbit is a fair example. Innocent and timid, entirely without weapons, it is always on the alert. With its large eyes, ears sensitive to the slightest sound, and a delicate sense of smell, it is as difficult to surprise as it is to "catch a weasel asleep." Every deer-stalker knows he must approach his game on the side opposite the wind. Most mammals, especially the herbivorous, scent danger, and flee away. Many of them use their natural weapons only when brought to bay, and in despair. This is true, indeed, of many carnivorous beasts when they are not bold with hunger. Birds rely, for warning of foes, more exclusively upon their eyes.

Excepting from man, the birds and beasts of prey have little to fear. Their offensive weapons are terribly effective. And, besides *teeth* and *claws*, the lion and tiger can strike such *blows* with their paws as will kill a buffalo at a stroke. The cud-chewing mammals have *horns* which may, with even the most timid, be efficient as a desperate resort. These are of various kinds as regards form, structure, growth, and duration. The principal kinds are represented by those of the deer, giraffe, antelope, and ox. The efficiency of these natural weapons is greater than would be imagined from a knowledge simply of our domestic animals. The water-buffalo of India (to quote from Wood) "is a most fierce and dangerous animal, savage to a marvelous degree, and not hesitating to charge any animal that may arouse its ready ire. An angry buffalo has been known to attack a tolerably sized elephant, and, by a vigorous charge in the ribs, to prostrate its huge foe. Even the tiger is found to quail before the buffalo, and displays the greatest uneasiness in its presence." Of the *gaur*, Wood says, "These herds . . . in their own domains bear supreme rule, neither tiger, rhinoceros, nor elephant daring to attack them." Some antelopes are on occasion quite a match for the lion.

The horn of the rhinoceros is very different from those of the ruminants. Its peculiar situation on the nose makes it a very ugly and efficient weapon. It is placed on the middle of an arch of bone, the latter being free at one end so as to give elasticity. Many animals, particularly the horse tribe, make excellent use of the *feet*. Of the use of the hind-feet, the mule is a striking but somewhat threadbare illustration. The elk and related animals strike with the fore-feet, and are able to cope with a dog or wolf.

The ostrich and the secretary-bird also *kick;* and the latter, as is also true of many birds, gives heavy blows with its wing.

The kangaroo uses his hind-feet less to kick than to *cut* and *disembowel* his antagonist. The bear employs much the same tactics. He *hugs* and crushes his antagonist with his fore-legs, and strikes and tears with either foot.

The elephant uses his great weight to literally crush his foe. But his weapon is his elongated *nose*.

Another example of the nose used as a weapon is found in the sword-fish. Here the bones of the skull are produced to form a thick beak, or *sword*, which points forward directly in a line with the body. With this lance, five or six feet long, the fish is able to pierce even through a ship's bottom. The British Museum is said to contain a sword imbedded in the planking of a ship. Accounts have been given of the sword-fish attacking and even killing the whale.

The saw-fish, a sort of shark, has a similar beak, not sharp pointed, however, but blunt and armed with teeth on either edge. It can be used as a lance, and has been deeply driven into a ship's timbers. It is used mainly for striking, and, if the animal attacked is moving, the

effect is a saw-cut. It then acts as a veritable *saw*. But it seems absurd for an animal to carry teeth on the outside of his nose.

With another shark the *tail* is a weapon, as it is with the whale also. The tail of the thrasher is extremely large, and can deal severe blows. The thrashers have been known to attack the whale when the latter is at the surface. It is conjectured that the thrashers and the sword-fish form a conspiracy against the whale, and, while the latter prevent the whale from diving, the former leap out of the water and bring their huge tails down on the naked back of the whale with a tremendous slap that can be heard a long way. Probably the whale is more frightened than hurt.

Some rays or skates have the tail long and whip-like. It is covered with sharp spines, and forms an effective instrument for either striking or grasping. These spines produce severe inflammation, and are greatly dreaded by fishermen. The larger ones are much used by savages for edging weapons. It is supposed that the whip-ray seizes an enemy, or its prey, with its tail, and kills it by the cutting spines on its tail, and by pressing it against the barbed spine situated on its back. These *spines* are commonly used as spear or arrow heads by the savages of the South Sea.

Some small creatures have *forceps* or jaws as weapons. Those of the lobster are modified feet, while those of the beetle are mouth-parts.

The most elaborate organs of defense are found in the lower forms of life. And at near the lowest point in the animal scale we find an apparatus exceedingly complex and efficient. This is the "nettling-threads," "lasso-cells," or *cnidæ*, which give the hydra, jelly-fish, and

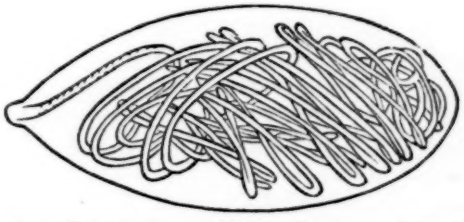

FIG. 9.—LASSO-CELL, CONTAINING BARBED FILAMENT. (After Gosse.)

polyps their power of stinging. They are also possessed by the crinoids, some naked sea-snails, and some sea-worms. Like many other weapons, they are used to subdue prey as well as to repel enemies. These creatures are soft and delicate, and would seem to be the easiest food for other animals. The *cnidæ* are probably their only defense, but they seem quite sufficient. A chapter would be required to give a full description of these wonderful weapons. The instrument consists of a hollow filament, coiled in a sac, the whole of microscopic size. The sacs are commonly on the surface of the tentacles and other free surfaces of the body. In some species they are collected in thread-

like magazines which are shot out of the body-walls. Upon irritation this hollow thread is thrown out of the sac to a great length, by eversion. It is turned inside out, and then exposes a barbed surface. They penetrate the soft tissues of the animal attacked, and convey a poison fatal to small animals. Any bather who has ever been stung by a jelly-fish can give a satisfactory account of the effect of these weapons. There is no doubt that a man would be completely and quickly paralyzed if entangled, in a nude state, among the tentacles of the larger jelly-fishes.

The *stings* of insects are more familiar, but still very wonderful. In the sting of the honey-bee "we see an apparatus beautifully contrived to enter the flesh of an enemy; two spears finely pointed, sharp-edged, and saw-toothed, adapted for piercing, cutting, and tearing; the reversed direction of the teeth gives the weapon a hold on the flesh, and prevents it from being readily drawn out. Here is an elaborate store of power for the jactation of the javelins, in the numerous

FIG. 10.—BARBED CASE OF EVERTED NETTLING-THREAD. (After Gosse.)

muscular bands; here is a provision made for the precision of the impulse; and, finally, here is a polished sheath for the reception of the weapons and their preservation when not in actual use. All this is perfect; but something still was wanting to render the weapons effective, and that something your experience has proved to be supplied." This is the poison, which has also a complex apparatus for its secretion and ejection. This sting is a modified ovipositor, and possessed only by the females, or neuters, which are undeveloped females. The male insect is always a mild and inoffensive creature.

Scorpion-stings are similar to those of insects in position and use, but are unlike in origin and development.

. The *poison-fangs* of venomous snakes are modified teeth. They are so attached that when not in use they lie in a fold in the upper jaw. The poisonous snakes have broad heads, on account of the muscles which control the fangs and the large glands which secrete the venom. The latter is a sort of saliva, probably charged with fermenting organisms, which are harmless in the food-canal, but which in the blood multiply with amazing rapidity. The poison is conveyed to the wound by a groove in the side of the fang.

The fangs of spiders represent the antennæ of insects. They are tubular, for conveying venom, and jointed. The point or terminal joint when not in use shuts into the basal joint, like the blade of a

pocket-knife into its handle. The fangs of the scorpion are modified feet.

Certain fishes have the power of storing a large quantity of *electricity*, which is used at will to paralyze and kill prey or enemies. The electric eel can kill small fishes at a distance, it is said, of fifteen feet; and they sometimes kill the horses which are driven into the pools for the purpose of exhausting and capturing the eels. The electricity is stored in a peculiar tissue of large cells or tubes which act like a battery of so many Leyden-jars. Apparently nervous force is here converted into electricity. After giving several shocks, the creature is exhausted for a time.

Besides those creatures which are passively offensive by their odors, there are others which can at will *expel fluids* to offend and deter enemies. The skunk need only be named, and the point will be fairly grasped by the reader. Some reptiles have the power to expel an offensive fluid from glands in the skin. The toad and salamander are examples. This fluid is acrid and biting, and intensely irritating to delicate skin, as the mucous membrane of the mouth or eye. The abundance of this viscid yellow fluid in the salamander probably led to the ancient notion that this little amphibian could withstand and extinguish fire. The water-beetle (*Dytiscus*) also expels a nauseating fluid.

FIG. 11.—THE TORPEDO, WITH ITS ELECTRICAL APPARATUS DISPLAYED. *b*, branchiæ; *c*, brain; *e*, electric organ; *g*, cranium; *me*, spinal cord; *n*, nerves to the pectoral fins; *nl*, *nervi laterales*; *np*, branches of the pneumogastric nerves going to the electric organ; *o*, eye.

It is very curious to find how some weak and lowly creatures succeed in frightening away their powerful foes. They assume a virtue which they do not possess. "The *attitudes* of some insects may also protect them, as the habit of turning up the tail, by the harmless rove-beetles, no doubt leads other animals, besides children, to the belief that they can sting. The curious attitude assumed by sphinx caterpillars is probably a safeguard, as well as the blood-red tentacles which can suddenly be thrown out from the neck by the caterpillars of all the true swallow-tailed butterflies."

Many creatures produce *sounds* for the same purpose. The cat spits. Snakes hiss. The porcupine rattles his quills. "Even the preliminary rustle of the quills with which a porcupine generally prepares every attack is sufficient to make an ordinary horse flee in terror." Perhaps the sounds produced by certain naked sea-snails are in some degree for defense.

Various lizards abash their enemies by expansion, protrusion, or erection of *appendages*. The iguana has a bag beneath the neck which it puffs up. The frilled lizard of Australia has a sort of Elizabethan collar about its neck which it can suddenly expand, to astonish and put to flight the approaching enemy. And the basilisk of South America has fin-like appendages upon its back and tail which it can erect if annoyed. The chameleon inflates his body with air, that he may appear to be a much bigger creature than he really is. From this sprang the belief that the chameleon lived on air.

The *phosphorescence* of animals is a subject not yet fully explained. But without doubt it is partly defensive.

One of the most queer and ludicrous methods of protection is seen in the bombardier beetles. In description of this, listen to Pouchet: "They alarm their enemies by means of real *artillery*. These coleoptera when threatened suddenly expel from their intestines a whitish acid vapor, the explosion of which as it issues produces a certain sound, a slight detonation, which carries disorder among the aggressors. This explosion may even be repeated a certain number of times. Hence, when one of these insects is pursued by an enemy, it fires off its artillery anew. The instinct of defense is so inherent in the tribe of bombardiers that, at the sound of a cannon-shot from one of them, all the others fire at the same time; there is a running fire along the whole line. The sound produced by these coleoptera is intense enough to startle those who do not know the *ruse*."

Truthfulness is not an inherent virtue of animal character. Many are the tricks, deceits, and devices by which they selfishly seek advantage. A common artifice is that of *feigning death* in order to escape the reality. "Playing 'possum" is a dodge not confined to those higher animals to which we in our condescension grant the possession of a degree of intelligence. The larva of the dytiscus, knowing the preference of fishes for living active prey, when seized immediately becomes flaccid and limp. The fish, supposing he has seized only a carcass, drops it in disgust, and the dytiscus makes the most of his opportunity. When the insect becomes a hard-skinned beetle, it, of course, loses this power, and then employs a disgusting fluid, as before mentioned.

Every collector of insects becomes familiar with species which have the habit of *quietly dropping* from the plants on which they feed to the ground, upon the least alarm.

Hunters are familiar with many wiles by which pursued animals endeavor to elude their pursuers and *throw them off the scent*. The fox has the habit of doubling on his track, of walking fences, and going into water. Wood thus describes the habit of a South African antelope, the duyker-bok: "If the sportsman should happen to overtake this buck, it will lie still, watching him attentively, and will not move until it is aware that it is observed. It will then jump up and

start off, making a series of sharp turns and dives, sometimes over bushes and at others through them. When it conceives that it is observed, it will crouch in the long grass or behind a bush, as though it were going to lie down. This conduct is, however, nothing but a *ruse* for the purpose of concealing its retreat, as it will then crawl along under the foliage for several yards, and, when it has gone to some distance in this sly manner, it will again bound away."

When a slug or naked snail enters a bee-hive, the bees fall upon him and sting him to death, as a matter of course. But what to do with the carcass then becomes a vital question. And now is exhibited the wonderful intelligence of the social insects. The body is too large for the bees to move; but if left it will breed pestilence. They cover it with wax; they embalm it, as did nations of old their dead. But a shelled snail entering the hive is invulnerable to their weapons, so they cement his shell to the bottom of the hive. It is a sentence of imprisonment for life, with no hope of pardon. Yet such manifestations of thought we call "instinct," because we wish to monopolize "intelligence."

Oddest of all defensive methods is that of *snapping off the tail.* The blind-worm, or slow-worm, is a little snake-like lizard common in

FIG. 12.—BLIND-WORM (*Anguis fragilis*).

the Old World. When alarmed it contracts its muscles in such manner and degree as to break its tail off at a considerable distance from the end. But how can this aid it? The detached tail then dances about very lively, holding the attention of the offender, while the lizard himself slinks away. And for a considerable time the tail retains its capability of twisting and jumping every time it is struck. The lizard will then grow another tail, so as to be prepared for another

adventure. There are other lizards which have a similar power, though in less degree. The American glass-snake, so called, is one.

Semper describes certain snails of the Philippine Islands which do the same thing: "Every species (*Helicarion*) that I personally examined possessed the singular property . . . of shedding their tails when they are seized somewhat roughly, at a little way behind the shell. This they do by whisking the tail up and down with extraordinary rapidity, almost convulsively, till it drops off; if the creature is held by the tail it immediately falls to the ground, where it easily hides among the leaves. . . . These snails at first constantly escaped me and my collectors in this way, and not unfrequently we had nothing but the tail left in our hand."

BRAZILIAN DIAMONDS AND THEIR ORIGIN.

By M. H. GORCEIX.

THE discovery of the diamond-beds of the Cape of Good Hope, with the extraordinary abundance of their yield, seems to have caused it to be forgotten that the empire of Brazil only a few years ago had the monopoly of that precious stone, as it still has of the finest crystals. Hopes have been entertained that the examination of the green serpentine, in which the Cape diamonds are scattered, would permit a determination of its origin and its primitive bed. No doubt, however, now exists that the magnificent crystals incased in that rock were already in existence when in its upward course from the depths of the earth it brought them along with it and left them where they are now found. Unless, then, new discoveries are made at the Cape, of beds of a different nature, it will be necessary to look to Brazil for the solution of the question of the primitive bed, the origin and the mode of formation of the diamond—a triple problem which appears, down to the present time, to exist as a challenge to all who are occupied with geology and mineralogy.

The diamond has been and still is mined at numerous points in Brazil, which are situated chiefly in the provinces of Bahia, Goyaz, Matto Grosso, Parana, and Minas Geraes. Except in the last province and in that of Bahia, they give occasion only to the labors of isolated diamond-workers, the *garimperos* of Brazil, who wash the sands of the streams in large wooden bowls. The principal diggings in Minas Geraes are grouped around the city of Diamantina, which is situated almost on the meridian of Rio Janeiro, about five hundred miles from the coast. A few other districts also furnish small quantities of diamonds. We shall consider especially the diamond-beds of Diamantina; and we need not then speak of the others, for they are all so

nearly alike that the study of one of them is enough to give an exact idea of the others. The country here is not one that we have to discover, but to make known, and it well repays a better acquaintance. If we go to it we shall run no dangers, we need fear or seek no thrilling adventures; but we may feel as much ease in traveling as we enjoyed a few years ago in going from Florence to Bologna, or on the road to the Apennines. The security is even greater. It is said that in Mexico military convoys have been necessary to guard the trains engaged in the transportation of silver from the interior to the coast, and that even these guards did not protect them. Never has a single soldier or a single agent of the police been employed in such service in Brazil. For nearly two centuries successive caravans and numerous travelers have transported to Rio Janeiro from the most remote points of the interior fortunes in diamonds or in gold, simply packed in wooden boxes; yet we can not cite a theft that has been committed on the roads, now great highways, which were still, hardly fifty years ago, simple bridle-paths traced through virgin forests.

The rocks are at first schistose; then, in the environs of Ouro Preto, the capital of the province, appear quartzose formations, sandstones, and quartzites. These rocks constitute the peak of Itacolumi and the enormous mass of Caraça, the landmarks that guide us. After a while the white or green mica of the quartzites is replaced by spangles of oligist iron, and for several leagues the dust of the road and the pavements of the streets of the towns through which we pass are formed of the most beautiful iron minerals in the world. Quartz, mica, and oligist iron are not generally elements of a very fertile soil, but, under the action of a considerable humidity, these rocks are disintegrated and decomposed. Wherever the hand of man has not carried destruction, there is developed, under the influence of a favorable climate, one of the finest vegetations in the world.

We are now in the land of gold. The road is everywhere marked with the ancient diggings; enormous heaps of gravel on the banks of the streams indicate how considerable have been the excavations of which we see only the persisting marks.

The rocks are always the same: mica-schists, quartzite containing mica or oligist iron, or itabaryte. The aspect of the country does not change: mountains succeed mountains, all of them rounded, gradually sloping on one side, carved into peaks on the other; and, since we follow generally the water-sheds, we have only brooks to cross, the sources of all the rivers that finally form the Rio Doce. But, after having passed the town of Serro and crossed, a few miles north of this, a chain of mountains perpendicular to the grand crest we have been following, the aspect wholly changes. Before us extends a vast plain, on which the eye hardly distinguishes a few undulations rising around the city of Diamantina, the red roofs of which are visible through a bouquet of verdure that forms a green oasis in the midst of the sur-

rounding desert. On the right, toward the east, we may perceive a peak, the summit of which, constantly surrounded with clouds, has never been reached—less on account of its height, which is not much more than six thousand feet, than of the precipices and deep clefts which forbid approaching it. It is the peak of Itaubé. On the left is seen a less elevated mountain, formed of a single block of rounded, rough-grained quartzite, which has been given the name of *Pedra Redonda*. From around these two peaks rise the principal brooks that, united, form the Jequitinhonha, a stream the sands of which yield diamonds to a considerable distance below Diamantina.

The quartzose rocks predominate everywhere; the schists are seen only at rare intervals, and in their beds. But those rocks, of which quartz in grains forms the principal element, are different from those we have met in the gold-bearing region. They are more granular, only slightly micaceous; they pass into real sandstones; and the beds, generally inclined a few degrees toward the east, are less dislocated, less metamorphic than those of the schists and micaceous quartzites which they cover, and which form an islet on which is situated the city of Diamantina.

To these quartzites and sandstones are added, on the banks of the Jequitinhonha and some of its affluents, conglomerates of rounded pebbles, the horizontal beds of which occur in the same region on the banks of the Paruna, a stream emptying into the Rio das Velhas. The schists and the lower quartzites containing green mica appear around Diamantina, and in patches in the bottom of the ravines through which the Jequitinhonha flows. Quartzites, sandstones superior to the preceding, and conglomerates crowning the whole series, such are the formations, to which heaps and dikes of diorite should be added, which form the soil of this diamond-bearing basin.

The surface, in consequence of the nature of the dominant rock, is covered with a bed of white sand marked by brilliant crystals of quartz derived from the numerous veins of that substance which penetrate all the strata. Of vegetable mold there is not a trace, except in the bottoms of the ravines. In the dry season, a few *kylmerias*, with knotty trunks and a thick rough bark like that of the cork-oak, humble *melastomas* with yellow and red petals, and the *opuntias*, with their straight stems covered with a spiny down, are not sufficient to hide the aridity of the soil. No cultivated fields, but widely scattered houses. Everywhere, however, the ground is dug deeply, and turned over, more by the hand of man than by the action of the elements; but the only product demanded of the earth is the diamond.

The region forms a vast ellipse, the major axis of which, running from north to south, extends about fifty miles from the city of Serro to the little river Caethe Mirim, and the other axis more than twenty-five miles from the Jequitinhonha to a line parallel with the Rio das Velhas. It is, in effect, situated in the valleys of both these rivers,

while a strip of it in the south, near the city of Serro, belongs to the basin of the Rio Doce. Capital differences are marked in the distribution of the diamond-bearing beds of these valleys.

In the basin of the Jequitinhonha, nearly all the water-courses, however insignificant, are or have been diamond-bearing from their sources to their mouths at that river. In the basins of the Rio das Velhas and of the Rio Doce, the streams cease to yield diamonds at a short distance from their source.

In these streams, the diamond is always accompanied by gold in flakes or in little nuggets; but while the diamond prevails in the center of the diamond-yielding region, as we move toward the east, the proportions are reversed: gold becomes more abundant; and finally, after having passed the city of Serro, it is the only precious substance contained in the sands. To this point penetrated, at the beginning of the eighteenth century, those bold adventurers, bands of whom, seeking gold for nearly a half-century previously, had crossed the mountains and reached the middle of the forest of the Sierra d'Espinhaço, dispossessing the tribes of savages whose last representatives still live miserably on the banks of the Rio Doce.

Often, down to 1729, the gold-hunters had noticed, in the bottoms of the bowls in which they washed the river-sands, little bright crystals, to which they attached no value. The brilliancy of these crystals, their hardness, and their regular form, as if shaped by the hand, had indeed attracted the attention of the miners, and many had saved them to use as counters in play; but gold alone had any value in the eyes of these adventurers. At this epoch, according to the least uncertain tradition, a monk, who had taken part in the search for diamonds in India, recognized the nature of these counters. He told his discovery to a certain Bernardo da Fonseca Lobo, who made it known in his name to the Portuguese Government. The king immediately took possession of all the lands where the presence of diamonds had been recognized, and where it could be suspected.

Bernardo received as his reward the title of royal notary, and the command of the militia of the most important city of the region. The name of the monk was forgotten. I do not believe that the name of either could have been popular at Minas, for their discovery, which threw hundreds of millions into the treasury of the kings of Portugal, was the origin of one of the most despotic rules that any country ever had to endure.

The first diamonds were found in the sands of the brooks; and these sands, or, to use the Portuguese expression which has passed into nearly all languages, *cascalhos*, still constitute the beds that are principally worked. But beds of an entirely different nature, situated, like mines of metals, in the midst of the strata, and of corresponding depth, have been brought to notice in later years.

The diamond-bearing cascalhos not only occupy, or rather did oc-

cupy—for most of them have been worked—the beds of all the water-courses, but they were also placed in beds on the table-lands and in the gorges of the mountains, at levels which the waters never reach in our day, even in times of freshet. They have a peculiar appearance, that never deceives the eye of the experienced miner. At first sight, they resemble the gravels of our rivers. They are formed of rounded pebbles of various colors, and are composed of numerous species of minerals, of which I, still only at the beginning of my studies of the subject, have already recognized more than thirty. Of these, quartz, the oxides of titanium, titanic iron, tourmalines, phosphates, fibrolite, octahedric oligist iron, and magnetite, which are well known to the miners and distinguished by them under various fanciful names, are the true satellites of the diamond, its veritable train, and are with rare exceptions sure to be found with it at Diamantina. They have so intimate a connection with it, in fact, that we are justified in believing that the same formations include the primitive beds both of these minerals and of the diamond. The form of the specimens leaves no doubt as to the causes to which they owe it. They have been brought down by the waters and worn round by friction. They can not, however, have been turned into spherical balls by a simple transport of a few hundred yards. The diamond itself, the hardest of all bodies, has not escaped this action; and fragments of it are found from which every trace of crystallization has disappeared, and which are as round as marbles. Not the sands of the large streams alone, but also those of the smallest brooks, even those near their sources, present the same characteristics. The stones must, then, owe their shapes to the polishings which they have suffered by being held in the windings of the rocks and rolled around them by the eddies of the waters. While they have been thus polished off, they have produced an analogous phenomenon on the bottoms of the rivers, where they have caused the wearing out of those circular holes—the "giants' pots," the *caldeiroes* of the diamond-hunters, with which the beds of the streams of Diamantina are pock-marked. The sands in these holes are naturally richer than the other sands; for the lighter elements are carried away by the water, and more fragile substances than the diamond are ground to powder in them. For a hundred and fifty years the miners have considered it a piece of great good fortune to discover one of these caldeiroes; but new ones are now very seldom found. A few hundred yards above the bridge of the Diamantina road over the Jequitinhonha, the course of the water is barred by enormous blocks of diorite, between which the current has excavated subterranean passages. The river having been partly turned from its course, one may now go into one of these grottoes, which is occupied by a cascalho of extraordinary richness. The sides of the rock are as polished as the best-worked marble; the light of the torches is reflected as from a glass; and the visitor perceives at every instant cylindrical holes as regularly formed as if some skillful potter had shaped

them on his wheel. The discovery of some of these caldeiroes after expensive labors, some thirty years ago, afforded sufficient return to enrich the families of the two partners who worked them. An eye-witness to the fact relates that in one of the holes under the diorite arch, when the superficial layer of sterile sand was removed, a clear mass of the precious stones was revealed, and the discoverers were able on the spot to fill their pockets with diamonds. In the Ribeirão do Inferno, a single caldeiroe of a few cubic metres' capacity furnished nearly 8,000 carats of diamonds. Such fortunes, however, are extremely rare, and can not be counted on in the regular mining.

It is easy to comprehend how powerful must have been the action of the erosion above described, the duration of which is measured by many millions of years, but is quite outside of our chronology. The greater part of the ravine through which the Jequitinhonha flows, as well as the whole groundwork of the hydrographic system of the region, is doubtless due to phenomena of upheaval, the directions of which oscillate around a north-and-south axis. The tributaries of that river have cut out channels for themselves which are now deep, close cañons, with sharply cut, precipitous walls.

The almost horizontal disposition of the sandstone strata, and of the conglomerates, which form the banks of the rivers, and the terraces which indicate the successive levels occupied by the river-bottoms, leave no doubt of the correctness of this assertion. At first, consequently, the bottoms of the streams were almost at the level of the surface; the rivers overflowed their banks after light rains, and their diamond-bearing sands were spread over the table-lands and in the mountain-gorges. As the beds of the rivers were worn down deeper in the rock, overflows became more rare, and the sands were carried to only small distances from the banks. Finally, after a certain period, inundations became impossible, and the sand was deposited in the caldeiroes, the caves, and subterranean channels which the river wore out in the rocks over which it flowed. This epoch may be referred to the period which preceded our own, and which is characterized in Europe by the stone implements of human origin and use, specimens of which have been found in the diamond-bearing land.

Then, either by a rising of the coast, or, as is less probable, by a subsidence of the central plateau of Minas Geraes, the fall of the streams diminished, and, instead of continuing to excavate their beds, they began to fill them with the diamondless, shifting deposits, the formation of which is continued into our day. The sands of the table-lands and the banks of the rivers are much less rich than those of the streams; and in any case the diamonds have to be separated, by methodical washings, from the foreign substances with which they are mixed. Very rarely a simple sifting with the fingers suffices to extract the jewel. In 1824 a region was discovered in the lower part of the table-land of Diamantina where the diamonds were scattered

through the soil, accompanied only by a few bits of quartz. According to the popular expression, the crystals of the precious stone could be picked out of the roots of the grass when it was pulled up. A diamond of twenty-eight carats was found on the surface of the ground. At some distance from this spot, I have myself seen, on the summit of the ridge between the valleys of the Jequitinhonha and the Rio das Velhas, diamonds in ground-cracks some inches deep, with no other companions than enormous crystals of quartz. Cavities in the rock a few metres away did not contain a trace of diamonds, although they bore identical crystals of quartz. The old miners ascribed the disposition of the minerals they sought in regular veins to the intervention of good genii. It seems as if, at Diamantina, a wicked fairy must have sown the diamonds on the ground according to its caprices; and never were caprices more whimsical and varied. The diamond there forms only an insignificant part of the gravels, and is in most uncertain proportions.

The work of washing the diamonds is done wholly by hand. In the first operation, the sands are placed, in portions of two hundred to two hundred and fifty pounds, in a kind of hod or rectangular trough, only three sides of which are inclosed. The hods are arranged by twos, fours, or sixes, by the side of a trough of water about a foot and a half deep, so that their bottoms shall be slightly inclined toward it. A workman, standing in the trough before each hod, dashes water upon the sand in it. The clay and the very fine sands are carried away, and the first separation is made. The larger pieces remaining in the top of the sand are picked away; the diamond is to be found in the two upper thirds of the mass that is left, the lower part being nearly sterile. The washing is afterward finished in bowls a little deeper and a little more conical than those used by the gold-washers. The washer puts the sand in the bowl and fills it with water; then by whirling the bowl and shaking it up and down while the sand is floating around in it, and being careful to stir it from time to time with his hand, he determines a classification in the order of density. This work is easy if he is washing gold; for that metal is heavier than the substances with which it occurs, and always goes to the bottom.

The diamond, however, having a density about three and a half times greater than that of water, and more considerable than that of quartz and tourmaline, but less than that of the oxides of iron and titanium, its constant companions, settles in the middle layers. The washer, after several rinsings, removes the upper particles, hardly looking at them, and, when he has reached a certain level, which his skill recognizes at once, tips his bowl slightly, so as to let the water run off in a thin film, and, perceiving the glittering crystals of the diamond, picks them out with his fingers. The vigilance of the overseers must be redoubled at this stage, particularly when slaves are employed; for I know of nothing equal to the skill of the slaves in find-

ing diamonds, except that with which they make them disappear if the vigilance of the superintendent is relaxed for an instant. I can not describe all the artifices employed, but I should remark that, since the works have become free, fraud has greatly diminished. Under the old rule it overtook half the diamonds in the gravels.

Difficulties of another kind are presented when the precious gravels are situated in the beds of the rivers. Since the channels have been deeply cut in the rock, and are bordered by steep cliffs, it is impossible to construct lateral sluices for turning the water away from them, except at an expense which even the magnificent return that is anticipated will not justify. A quicker and more simple process has been devised. The river is dammed, and a flume is made of planks to carry the water from the dam to some three or four hundred yards below. The intervening space between the dam and the end of the flume, in which the precious gravels of the caldeiroes are supposed to be situated, is thus left free from running water, while the water which stands upon it and that which reaches it by infiltration are removed by pumps worked by water-wheels. The work must be done quickly when this system is employed, for there is no time to lose. The river is generally docile enough during the dry season, from May to October; but, if only a slight storm comes on, it is transformed at once into a torrent that nothing can resist, and which carries off dams, wheels, and viaduct. This is what happens, as a rule, fifty times out of a hundred. I know of diamond-seekers who have recommenced for three or four years in succession the same works, to have them every time destroyed under their eyes by sudden freshets. Then a fortunate season has amply recompensed them for all that they had lost. Others have just had time to work for a few days in the rich beds, a few cubic yards of which have yielded them hundreds of carats of diamonds; but how many have exhausted all their resources without reaching this promised land! Nevertheless, no machines, or barrows, or inclined planes are employed, notwithstanding the enormous force furnished by the fall of water in the race is at the disposal of the operator; only picks, shovels, levers to raise the rocks, and, for means of transportation, laborers, who carry on their heads large wooden troughs, which others fill with sand and stones. Nothing can be more picturesque than these great trenches, where crowds of negroes are moving about like ants in an ant-hill, running in gangs to receive their loads, and carrying them away in groups, while they intone songs, which are almost always in the language of the African coast. The excavation becomes deeper and more sinuous; groups of men, like clusters of bees, hang, by the aid of the most primitive of ladders, to the rock-walls, and the work goes on with a feverish ardor. From time to time, the overseers probe the sand with long iron rods. Great is the rejoicing when the existence of the diamond-bearing cascalho beneath the sterile sands is revealed by a peculiar sound which all the miners know.

As great, also, is the disappointment when, as often happens, the probe strikes the rock without meeting the diamonds—they having been already taken away by the miners of the previous century, all traces of whose former presence have been destroyed by the river. This is another risk that the diamond-seekers have to run.

These gravel-beds are not the only treasure-bearers in the diamond-yielding region. The mineral elements of which they are composed have been washed by the waters from more ancient rocks. Now, what are these rocks? Do they still exist, or have they been wholly destroyed? To answer these questions, I have carefully endeavored to determine the group of minerals which I have called the satellites of the diamond, persuaded that, wherever their primitive bed should be found, there would also be met that of the diamond. Now, all around the city of Diamantina, and for more than twenty miles west of it, the dominant rocks are quartzites with green mica, and beds of schists of the same nature and the same age as those of the auriferous formations. They are traversed by numerous veins of quartz containing oxides of iron, titanium, and tourmalines, the satellites of the diamond in the river-gravels. The origin of the latter is evidently due to the destruction of these rocks by the action of the waters; and we may, therefore, conclude that they ought to contain the primitive bed of the diamond.

The study of the geographical distribution of the diamond-bearing streams leads us to the same conclusion. All the streams, the sands of which have been found to be richest in diamonds, depart from this zone.

These deductions are confirmed also by the two facts of the discovery of the diamond in place in the sandstones with green mica, two hundred miles from Diamantina, and the discovery of clay-beds, formed from the decomposition of the schists intercalated in the quartzites, twenty miles west of the same city, where rise two rivers, the Rio Pardo and the Caethe Mirim, celebrated in the annals of the miners for their richness. The idea that the Brazilian diamonds were found only in alluvial deposits was so firmly rooted that at first no one attached importance to these discoveries. I was myself incredulous respecting them till I was able to verify with my own eyes the existence of the diamond in the rocks in place. I distinguished three formations: one white, with considerable quantities of crystals of quartz; a second gray, composed almost entirely of oxide of iron; the third, the strongest, of mottled clay, with considerable quantities of the same crystals, of rutile and oligist iron, which I have already pointed out as occurring in the river-gravels. All the formations are strongly inclined toward the east, and are intercalated with micaceous quartzites, the turns of which they follow; and were, therefore, formed at the same time with them in remote geological epochs, which, in consequence of the total absence of fossil remains, can not be precisely

identified. A comparison of them with other strata of the São Francisco Valley, which are characterized by the presence of palæozoic corals, permits me to affirm that they certainly ascend as far back as the Silurian period. Other travelers, previously to myself, have mentioned this formation, and my friend the geologist Dorville-Derby, who supports my view, has carefully described it. The washing of these clays is performed in the same manner as that of the gravels, and I have myself extracted diamonds from them. In the washing, the minerals which we found rolled and rounded in the river-sands, and presenting an entirely different aspect, came out in perfect crystals, without a trace of wearing. They are the same satellites of the diamond, but still in their primitive bed. The diamonds also of São João da Chapada are characteristic: like the crystals of oxide of iron, their angles are whole; their wrinkled faces and their uniform color have suffered no modification by friction. Should not the same conclusion be adopted for the diamond, and may we not assume that it also is here found where it was formed? It is true that I have not found diamonds actually in the little veins of quartz that traverse these beds, nor in the schists, the decomposition of which has produced the diamond-bearing clays with these same crystals of oligist iron and rutile. But hardly one diamond exists to a million crystals of oligist iron; more than thirty thousand pounds of clay have furnished only ten little diamonds weighing about a carat. It would have been a rare chance to perceive, even with a strong glass, one of these stones, no larger than the head of a pin, in the midst of an enormous mass of sterile substances. Objections may indeed be made to the views which I have presented. The formations in which the diamond is found have not always been in the condition in which we now see them. They are not eruptive rocks, that have come already formed from the center of the earth, but have originated from the destruction of more ancient formations, and have undergone metamorphic action under the influence of which new crystalline elements have been formed within them, and they have assumed the aspect they now present. Why, it may be asked, may not the diamond also have been derived from these primitive formations? And then the problem, instead of having been resolved, is only put back another step.

I may reply to this by asking if the processes of trituration effective enough to reduce crystals of feldspar and quartz to mud and sand would not also have modified the diamonds by smoothing their angles and wearing away their surface; especially, since we have seen that much lighter rubbings have been enough to produce such effects in the streams? I could likewise answer other objections that my mind suggests; and I believe I have shown that the diamond of the alluvial formations of Diamantina comes, like the iron and titanic oxides, the tourmalines and the phosphates, its faithful companions, from the destruction of the quartz-veins intercalated into the palæozoic rocks of

the region. The constant association of this precious stone with those minerals causes me to believe that it has been brought, like them, from the depths of the earth in the condition of a volatile compound, and that it owes its crystallization to a dissociation produced under the action of heat and a considerable pressure. Now, what is this volatile compound?

As to the oxides of iron and titanium, together with what takes place in volcanoes, the synthetic experiments of M. Daubrée leave no doubt that they have come up as chlorides and fluorides. May the case not be the same with the diamond? Its presence in the midst of a crystal of anatase lends support to this hypothesis. This is, it is true, only an hypothesis; but it is an hypothesis based on the observation of phenomena in which I have taken analogy for my guide. Far be it from me to assume that I have resolved the problem. I shall be well satisfied if I shall ever be able to raise the corner of a veil which more fortunate and more skilled men than myself will, I am convinced, eventually remove completely.

It is very difficult to estimate the quantity of diamonds furnished by Brazil. Between 1772 and 1793 the royal treasurer received 877,717 carats of diamonds, or about 38,000 carats a year. At least as many more were stolen or smuggled away. This would make the annual production in round numbers about 80,000 carats; if we assume this average for a total period of a hundred and fifty years, we reach the figure of 12,000,000 carats, or nearly 2,400 kilogrammes (6,000 pounds), or a volume of seven or eight hundred quarts. It is impossible to calculate even approximately the total value of these stones. Generally, the diamonds of Brazil are small; stones of fifteen or twenty carats are rare; and the Star of the South, a stone which was found in the western part of the province, at Bagagem, is the only one of them that calls for a special mention. This diamond weighed, in the rough, 254·5 carats, and, after being cut, 125 carats. Finds like this are very rare; and I know of miners who have washed and washed over the cascalhos of Bagagem for twenty years, without having found a second Star of the South, or even a single diamond of value. They are still, however, far from giving up the search. The total production of Brazil in 1880 hardly exceeded sixteen kilogrammes, or forty pounds (about 80,000 carats). In the same time, the mines of the Cape yielded 2,000,000 carats. The Brazilian diamonds, however, have a very marked superiority in luster and beauty, so great that they have often been taken for Indian brilliants.

THE FUNCTIONS OF AN AMERICAN MANUAL TRAINING-SCHOOL.*

By Professor C. M. WOODWARD, Ph. D.,
of the Washington University, St. Louis.

WITH his gentle lance Emerson pricked many a bubble, and, though collapse did not always follow immediately, the wound was always fatal. In 1844, in his essay on New England reformers, he charged popular education with a want of truth and nature. He complained that an education to *things* was not given. Said he: "We are students of words; we are shut up in schools and colleges and recitation-rooms for ten or fifteen years, and come out at last with a bag of wind, a memory of words, and do not know a thing. We can not use our hands, or our legs, or our eyes, or our arms." And again, speaking of the exclusive devotion of the schools to Latin, Greek, and mathematics, "which, by a wonderful drowsiness of usage" had been "stereotyped education, as the manner of men is," he says: "In a hundred high-schools and colleges this warfare against common sense still goes on. . . . Is it not absurd that the whole liberal talent of this country should be directed in its best years on studies that lead to nothing?"

This is evidently too severe, but we must admit that Emerson anticipated and greatly aided a reform which has been gathering strength for a whole generation. Hence it is to-day scarcely necessary that I should present arguments in favor of manual education. The great tidal-wave of conviction is sweeping over our whole land, and the attitude and aspect of men are greatly changed from what they were ten years ago. What I said in 1873 in a public address in favor of technical education was held to be rank heresy. I fear it would be regarded as rather commonplace to-day. The progressive spirit of the age has actually penetrated our thick hides, and we are trying to keep step with the universe.

In every community the demands of technical education have been discussed, and, in every instance when the old system has been subjected to the tests which good sense applies to business, it has been found wanting.

Defective Education.—Is, then, I ask—is the education we give as broad and round and full as it ought to be? Is the time of tutelage most wisely spent? Do the results we secure justify the means and methods we use? Is the relation between education and morality as close as it should be? Does our education fill the definition of

* Address delivered at Saratoga Springs, New York, on Thursday, July 13th, before the joint meeting of the National Teachers' Association and the American Institute of Instruction.

Pestalozzi? I think to these questions we must seriously answer: No! There is a lack of harmony between the school-house and the busy world that surrounds it. Some have even claimed that we are wrong in supposing that education diminishes crime. Let us see if there is any truth in their position.

You know how often a life is a failure from defective education. Too often do we see young people, who might have been educated to eminent usefulness, cast

". . . unfinished
Into this breathing world scarce half made up."

I have seen poor lawyers, who, under a proper system of training, would have made excellent mechanics, and not a few highly educated, able-bodied men actually begging for the price of a day's board. I recall one man in particular who was able to speak several languages, but because no one would employ him as a linguist he must needs beg, for he knew not how to work. Now, when a man's education has been misdirected, and he is thrown upon the world shackled by outgrown theories, bewildered by false lights, and altogether unprepared for the work which perhaps he was born to do, and when in his extremity he resorts to knavery and violence and fraud to secure what he knows not how to get by fair means, those who directed or should have directed his education can not be held blameless.

The moral influence of occupation is very great. A sphere of labor congenial and absorbing, that fully occupies one's thoughts and energies, is a strong safeguard of morality. If you would keep men out of mischief, keep them busy with agreeable work or harmless play. The balance of employments is fixed by our state of society and the grade of our civilization. Now, if indiscriminately we educate all our youth away from certain occupations and into certain others, as is very clearly the case, some employments will be crowded, and consequently degraded; in others, the choicest positions will be filled by foreigners, and the lowest posts, wherein labor is without dignity, must perforce be filled by those who have neither taste nor fitness for their work. The result is broils, plots, and social disorder.

Thirty years ago an eloquent Frenchman (Frédéric Bastiat) charged the one-sided education of his countrymen with being an actual danger to society. He argued that the "stranded graduates," as he called those who, unable to navigate the rough waters of practical life, had been tossed high and dry on the reefs along the shore, "filled with a sense that the country which had encouraged them to devote their best years to classic studies owed them a living, or a means of living, would become the leaders of mobs and officers at the barricades."

More Light.—When the shadow of death was drawn over the great Goethe, he uttered his last wish for "more light." We must echo his cry, if we would prepare our American system of education for a more glorious destiny. We treat our children too much as the

unskilled gardener treats his plants. He puts them by a window, and pours over them a flood of light and life-giving rays. Instinctively they turn out toward the source of their strength. They put forth their leaves and budding promises, and, as we look at them from the outside, we mark their flourishing aspect and rejoice. But, if we look at the other side, we shall find them neglected, deficient, and deformed. What they want is more light—light on the other side. Were the sun always in the east, our trees would all grow like those on the edge of the forest, one-sided.

So in education, we must open new windows, or rather we must level with the ground all artificial barriers and let every luminous characteristic of modern life shine in upon our school-rooms. We must pay less heed to what the world was two or three hundred years ago, and regard with greater respect what the world is to-day.

THE ARTS OF EXPRESSION.—Dr. Youmans recently said ("Popular Science Monthly," May, 1882): "The human mind is no longer to be cultivated merely by the forms or arts of expression. The husks and shells of expression have had sufficient attention; we have now to deal with the living kernel of truth. . . . Under the old ideal of culture, a man may still be grossly ignorant of the things most interesting and now most important to know. . . . Modern knowledge is the highest and most perfected form of knowledge, and it is no longer possible to maintain that it is not also the best knowledge for that cultivation of mind and character which is the proper (i. e., the highest) object of education."

I desire, for a moment, to direct your attention to the arts of expression. Next in rank to the ability to think deeply and clearly is the power of giving clear and full expression to our thoughts. This last can be done in various ways. As this brings me squarely upon a subject I wish to impress strongly upon you, I will illustrate it by a somewhat elaborate example:

A gentleman recently called upon me for my opinion concerning a certain automatic brake for freight-cars. The device was new to me, but it lay pretty clearly defined in the mind of my visitor. It was not original with him, but for the purposes of my illustration it might have been. Before I could pass judgment, the device must lie as clearly in my mind as, perhaps more clearly than, it did in his; so he set out to express his thought. He was what we call well educated, being a graduate of the oldest university in the land, and was well versed in the conventionalities of spoken and written languages. Accordingly, he proceeded to utter a succession of sounds. His lips opened and shut with great rapidity, and without intermission a series of sounds fell upon my ears. The sounds I heard were quite familiar to me, as I had been listening to them in one order and another for over forty years, and, as they had always been associated in my mind with certain concrete things and the relations of such things to each

other, certain thoughts about those things began to take shape in my mind.

Of course, the sounds I heard had not the smallest likeness to the things called up by them in my mind. To an Italian peasant, or to Archimedes of Syracuse, they would have been as unintelligible as the chattering of a magpie. They were purely arbitrary or conventional; yet, much of our education had been devoted to their mastery. Nevertheless, as a means for expressing thought, they were, in the present case, quite inadequate. The ideas aroused in my mind were confused and fragmentary, and altogether unsatisfactory. The images lacked precision. Had my friend resorted to writing a description of the invention, in either English, French, German, Latin, or Greek, using in every case a set of purely conventional symbols (to represent the other set of conventional sounds), which we had both spent years in getting some knowledge of, he would have succeeded little better. Whether speaking or writing, much of his thought he could not clothe in words. He, therefore, abandoned the wholly conventional, or verbal, art of expression and turned to the pictorial.

But, here he soon confessed that his education was deficient. He had never studied the art of representing objects having three dimensions on a surface having but two, and hence he was ignorant of the methods he ought to adopt to express by drawings the objects he was thinking of. However, I caught more of his meaning from some crude attempts at sketching than I had from all his talk. A few lines were luminous with meaning; yet, they left far too much for me to supply by my imagination; hence, my visitor withdrew and sent me a full set of what we called "working drawings," made by the inventor, who was a draughtsman.

These drawings, though a sort of ocular resemblance to the things signified, were still half conventional, and required, on my part, a certain amount of training to enable me fully to understand them; this, fortunately, I had received, and, through the art of expression embodied in them, I gained a tolerably clear idea of the thought of the inventor. With scarce a written or spoken word, they expressed that thought far more clearly and fully than any merely verbal description could do; they showed the relations of parts which were beyond the reach of words.

But my friend was not content to stop there. The drawings had been but partially intelligible to him with their "plans, elevations, and sections," and, judging me by himself, he believed that a third art of expression would outvalue both the others; he, therefore, invited me to call at a shop and examine a specimen of the device itself, produced by a skilled mechanic. The *real article*, which is the mechanic's art of expression, proved to be an improvement even upon the thought of the inventor. The latter had not been a mechanic, and he had made the sort of mistakes that draughtsmen, who are not something of

mechanics, always make. Certain parts it had been practically impossible to construct, as they involved shapes that could not be molded by ordinary means. A nut had been placed where it was next to impossible to turn it; and certain parts which were to be of cast-iron had been given such dimensions that the castings would have snapped in pieces while cooling. These errors had been corrected by the mechanic, and the perfected thought lay fully expressed before me.

In this illustration we have three greatly different methods of expressing essentially the same thought. Each constitutes a distinct language, and each is absolutely essential to modern civilization.

You will note how a crude thought often takes practical shape in the hands of the draughtsman and the mechanic. "Drawing," says Professor Silvanus P. Thompson, "is the very soul of true technical education, and of exact and intelligent workmanship." Those who have tested this can tell how many marvels of ingenuity, as lovely as *châteaux en Espagne*, have vanished in the presence of "plans and elevations"; and how many beautifully drawn designs have been mercilessly condemned as impracticable by judges versed in the laws of construction and the strength of materials.

Much more could be said upon the arts of expression, their relative importance and proper cultivation. You will readily think, as did Lessing in his Laocoon, of poetry, painting, and sculpture. You will recall how lofty thoughts have in all ages found expression in architectural forms, and yet, throughout all the history of architecture, the laws of mechanics as then understood and the properties of the materials used have determined the different styles. In our own age we are trying to express ourselves in iron and steel, and to cast off the fetters of an age of marble and granite.

In a recent address Mr. Charles H. Ham, of Chicago, said that, by putting thought into seventy-five cents' worth of ore, it is converted into pallet-arbors worth $2,500,000. He continues: "Skilled labor is embodied thought—thought that houses, feeds, and clothes mankind. The nation that applies to labor the most thought, the most intelligence (i. e., that best expresses its thought in concrete form), will rise highest in the scale of civilization, will gain most in wealth, will most surely survive the shocks of time, will live the longest in history."

But some one will say, as to methods of expression: "One art is enough for me; make me master of one, and I will care for no second." I answer, you are thinking of an impossibility. If a mechanic is only a mechanic, he is never a master, even of his own art. He is crippled at every turn; in expressing himself, he is limited to what he can make. He is without that powerful ally, drawing, the short-hand of the imagination, and in the presence of thoughts that baffle concrete expression he is dumb. Valuable machines even are sometimes purely imaginary. Clerk Maxwell, in his "Theory of Heat," says: "For the purposes of scientific illustration we shall describe the working of an

engine of a species entirely imaginary—one which it is impossible to construct but very easy to understand," referring to Carnot's engine. In like manner, if one would command confidence as a draughtsman he must be a mechanic as well. And, finally, if I am a student of words alone, and if I go not beyond my dictionaries, I shall never guess their meaning. A large proportion of our emphatic words are technical; they belonged originally to some craft, and none but a craftsman knows their exact meaning. President Eliot, of Harvard, once said that the highest education was that which gave one the fullest and most accurate use of his mother-tongue. I would modify the statement, and claim that the highest and most liberal education is that which, besides cultivating most fully the powers of thought, gives one full command of all the arts of expression.

I need not remark that many, perhaps most thoughts, do not admit of concrete nor even of pictorial expression, as, for example, all abstractions; hence they suffer seriously from want of clearness. If you have a clear thought on abstract matters you can never be sure you have expressed it clearly.

Before we devote ourselves exclusively to the arts of expression, we must cultivate all the faculties and encourage the growth of thoughts worthy of expression. The thought must precede its expression by any method, and in the cultivation of the thinking mind the concrete should precede the abstract. Give children clear and accurate thoughts of real things, of the material world we live in, of real plants and animals, of the laws of materials, of qualities and then of quantities, before you venture on the field of abstractions. Before you cultivate the high arts, make sure of the low ones; without them as a foundation no superstructure of fine art can stand overnight. As Emerson says (in "Man, the Reformer"): "We must have a basis for our higher accomplishments, our delicate entertainments of poetry and philosophy, in the work of our hands. We must have an antagonism in the tough world for all the variety of our spiritual faculties, *or they will not be born.*"

A habit of clear thinking once formed will never leave us, however abstract our investigations become; while a habit of stopping short with ill-defined results, of resting content with obscure and half-grown mental images, a mental attitude of fogginess, has a stultifying effect which seriously dwarfs the mind. This is a most important subject, but I have place for but a few words of exhortation. Give children clear thoughts, and begin with the concrete. When the mind is too weary or too sick to clear up obscurities, it is time to seek rest and recreation and fresh air. Beware of straining the powers of attention by too much schooling; beware of overtaxing the mind by too many and too difficult subjects, and especially beware of poisoning the blood and debilitating the brain by bad air. The fruit of any and all these evils is mental as well as physical decrepitude.

THE AIMS OF EDUCATION.—But to return. I claim for these forms of expression, which I have taken pains to distinguish, more nearly equal care and consideration in the elementary education of every child. Teach language and literature and mathematics with a view to make each child a master of the art of verbal expression. Teach mechanical and free drawing, with the conventions of shade and color, and aim at a mastery of the art of pictorial expression. And, lastly, teach the cunning fingers the wonderful power and use of tools, and aim at nothing less than a mastery of the fundamental mechanical processes. To do all these things while the mind is gaining strength and clearness, and material for thought, is the function of a manual training-school.

PREJUDICES TO BE OVERCOME.—The traditions are heavily against us, but the traditions of the fathers must yield to the new dispensation. As was to have been expected, the strongest prejudices against this reform exist in old educational centers.

As President Walker, of the New York Board of Education, frankly admitted at the laying of the corner-stone of Professor Felix Adler's splendid institution, "The Workingman's School and Free Kindergarten," the methods and aims proposed by the advocates of manual training-schools are a criticism upon the methods and aims of the established system, and nothing is more natural than for it to resent the criticism and discourage reform.

No man has done more—nay, no man has done as much—to introduce the manual feature into American education as Professor John D. Runkle, of Boston, and yet the School of Mechanic Arts established by him in connection with the Massachusetts Institute of Technology has, after an existence of several years, been apparently almost frozen out in the biting atmosphere of that highly æsthetic city. I doubt if one could find on American soil a more unpromising field for a manual training-school than beneath the lofty elms of Cambridge and New Haven.

LUXURIES IN EDUCATION.—There are luxuries in education, as in food and dress and equipage, and in wealthy communities the luxuries command the chief attention. At the English Universities of Oxford and Cambridge, a large proportion of the students expect to be gentlemen of leisure. The idea of giving heed to the demands of skilled labor, of preparing for lives of activity and usefulness—the idea of earning one's daily bread and of supporting one's family—scarcely enter their heads. Either they inherit livings, or they seek to get livings through the Church, or they enter the army with commissions purchased by kind friends who wish to get them out of the way, or they go into law or politics. It is no wonder that such men devote themselves largely to the luxuries of education—Greek, astronomy, philology, higher mathematics, Latin hexameters, Italian—in a word, to "polite" learning. In such an atmosphere as that how incongruous

is the plea of mine for an education to things; for a training of the hand and eye as well as the intellect to lives of useful employment! Yet half the colleges in the United States ape the English universities, and half the high-schools ape the colleges.

The result of all this has been a certain false æstheticism which turns away from the materialism of our new notions. The highly cultivated would soar away into purer air and nobler spheres. There is a feeling more or less clearly expressed that the material world is gross and unrefined; that soiled hands are a reproach; that the garb of a mechanic necessarily clothes a person of sordid tastes and low desires. As Dr. Eliot, of St. Louis, has expressed it, "It is thought to be a sad descent for a university whose aim should be the highest education to stoop to the recognition of handcrafts of the mechanic."

Manual Education.—Perhaps no better general statement of the new creed has been made than that of Stephen A. Walker, in a speech already referred to. He put it for us thus: "Education of the hand and the eye should go along, *pari passu*, with the education of the mind. We believe in making good workmen as well as in making educated intellects. We think these are things that can be done at the same time, and our proposition is that they can be done better together than separately."

As I said in the beginning, this proposition is meeting with general favor among the people. I have pointed out the sources of some of the opposition; it remains for me to touch upon the two objections which I surmise are about the only ones in the minds of my hearers. You ask first, "Is your proposition practicable?" You doubt the feasibility of uniting in a real school such incongruous elements as arithmetic and carpentry, history and blacksmithing. You fear either that the shop-work will demoralize the school, or that the shop-work will never rise above the dignity of a mere pastime.

Now, I claim not only that what I propose can be done, but that it has been done in St. Louis, and perhaps elsewhere as well.

Organization of a Manual Training-School. — Professor Thompson, in his valuable essay on the apprenticeship schools of France, classifies French technical schools under four heads:

1. The school in the workshop or factory.
2. The workshop in the school.
3. The school and the shop side by side.
4. The half-time schools.

To the first class the school is subordinate to the factory; the boys or girls learn a particular trade, and everything in the school as well as in the shop is designed to meet the wants of those expecting to enter the particular trade. For obvious reasons there can be no general adoption of such a combination in the country. Professor Thompson gives his verdict in favor of the school and the shop side by side, though there is much to recommend the second plan.

No one of the French plans exactly suits me. I prefer to incorporate manual with intellectual education, and include both under the name school. We do not have what you call school in the morning and shop in the afternoon; nor do we spend the forenoons with tools, and devote a few evening hours to study and recitation.

The Manual Training-School of St. Louis differs from all other technical schools with which I am acquainted. It much resembles the Boston School of Mechanic Arts, though it differs from it in admitting boys at fourteen instead of fifteen years of age; in having a three years' course instead of two, and in having a full and independent equipment of study and recitation rooms, as well as shops. I gladly avail myself of this occasion to publicly acknowledge our indebtedness to the able reports and papers published by ex-President Runkle on the Russian system of tool-instruction and the organization and work of his school.

PROSPECTUS OF THE SCHOOL.—A prospectus of our school has just been issued, giving in detail our course of study, and the methods of tool-instruction. I shall be happy to give a copy to every one who is sufficiently interested to ask for it. To those who do not care for the details, I will say that our course of study runs through three years, in five parallel lines:

1. A course in pure mathematics.
2. A course in science and applied mathematics.
3. A course in language and literature.
4. A course in penmanship and drawing.
5. A course in tool-work in woods and metals.

Our school is not managed on the assumption that all the boys who go through it will become mechanics, or that they will be manufacturers. Our graduates will doubtless be found in all the professions. We strive to help them find their true callings, and we prejudice them against none. I have no sort of doubt, however, that the grand result will be that many who otherwise would eke out a scanty subsistence as clerks, book-keepers, salesmen, poor lawyers, murderous doctors, whining preachers, abandoned penny-a-liners, or hardened school-keepers, will be led, through the instrumentality of our school, to positions of honor and comfort as mechanics, engineers, or manufacturers.

NO ARTICLES MADE FOR SALE.—For the purpose of discountenancing certain grave popular fallacies in this country, I will add a word, even at the risk of repeating what I have said elsewhere, as to our plan of shop management. We do not manufacture articles for sale, nor do we pretend to fully teach particular trades.

A shop which manufactures for the market, and expects a revenue from the sale of its products, is necessarily confined to salable work, and a systematic and progressive series of exercises is practically impossible. If the shop is managed in the interest of the student, he is allowed to leave a step or a process the moment he has fairly learned

it; if it is managed with a view to an income (and the school will be counted a failure if its income is wanting), the boys will be kept at what they can do best, and new lessons will be few and far between. In such a shop the pupils will suffer too much the evils of a modern apprenticeship.

"The common apprentice is a drudge set to execute all kinds of miscellaneous jobs. There is no systematic gradation in the difficulty of the exercises given him; more than half his hours are purely wasted, and the other half are spent on work unsuited to his capacity. What wonder that four, five, or six years make of him a bad, unintelligent, unskillful machine!" (Professor Silvanus Thompson).

A very bright boy of seventeen years had expected last fall to enter a pattern-shop in St. Louis as an apprentice, but was disappointed, there being no vacancy in the number of apprentices allowed. He therefore came to the Manual Training-School, and during the year made excellent progress, not only in carpentry and wood-turning, but in drawing, mathematics, and physics. When he showed me some of his handiwork at the end of the year, I asked him if he would have made equal progress as an apprentice. "No," said he, "I should have spent most of the first year sweeping out offices and running errands."

(Since the above was written, a gentleman told me of his father's experience when learning the trade of a tanner in Philadelphia, many years ago. He lived in the family of his employer, and during the first six months *he tended the baby.*)

Self-supporting Schools.—I fancy there is no more pernicious fallacy than this of making a school self-supporting by manufacturing for the market. Suppose you attempt to maintain one of these popular humbugs, a commercial college, on that theory, or to run a full medical school without endowment on the self-supporting plan (the students would probably write prescriptions cheap, and cut off legs for half price); or to manage a public school of oratory and English composition on the strength of an income derived from contributions to newspapers and magazines, and from orations made and delivered to order. Nothing could be more absurd, and yet the cases are closely parallel. No; do not be beguiled by the seductive promise of an income from the shop. Admit from the first the well-established fact that a good school for thorough education on whatever subject costs money, both for its foundation and its support.

Closely connected is the matter of teaching particular trades, to which the lads shall be strictly confined. Such a course may work well in monarchies, where the groove in which one is to run is cut out for him before he is born; but it is unsuited to the soil and atmosphere of America. A single trade is educationally very narrow, while their number is legion. "The arts are few, the trades are many," says Mr. Runkle. The arts underlie all trades; therefore let us teach them as

impartially and thoroughly as possible, and then it is but a step to a trade.

And this brings me to a very important point. Admitting that, with a suitable outfit of tools, shops, etc., a programme such as I have described can be carried out, you ask: "What, after all, is the manual training acquired at school good for? Has the mind been nourished through the fingers' ends? Has the hand gained any enduring skill? Is it really but a step from the door of the manual training-school to the shop of the craftsman?"

Experience answers all these questions satisfactorily, and adds that there is scarcely a calling in society that is not edified by manual training. Rousseau once remarked that "to know how to use one's fingers gave a superiority in every condition in life." I recently made systematic inquiry among the parents of my boys as to the effect of the one or two years' training in our school. Their reports on the points now under consideration are both interesting and encouraging. They write:

"Gerald takes great interest in fixing up things generally."

"Charles fixed my sewing-machine."

"George has made many little matters of household utility, and seems to delight in it."

"We go to Henry to have chairs mended, shelves put up, etc., and he does excellent work. He made a fine set of screen-frames."

"The mechanical faculty was quite small in John's case, and it has been developed to a remarkable extent."

"Leo does all the jobs around the house."

And so on, for nearly a hundred pupils.

Again, the parents testify to an increased interest in practical affairs, in shops and machinery, and in such books and periodicals as the "Scientific American." Beyond question, there is a certain intellectual balance, a good mechanical judgment, a sort of level-headedness, in practical matters consequent upon this sort of training, that in value far outweighs special products. Said Rousseau, in his "Emilius," one hundred and twenty years ago: "If, instead of keeping a boy poring over books, I employ him in a workshop, his hands will be busied to the improvement of his understanding; he will become a philosopher while he thinks himself only an artisan."

As to enduring skill, I will let you judge for yourselves. The blacksmithing has occupied the second-year class about two hundred hours—ten a week. Each man had his forge and set of tools, and each executed substantially the same set of pieces. Here is a partial set of the work done. The pieces are numbered in the order in which they were done. They were first wrought in cold lead while the order of the steps and the details of form were studied, and then they were executed in hot iron. I have a few of the lead specimens here. The boys have not yet learned to weld the lead. The instructor's estimate

of each piece is shown in the per cent stamped on it. The pair of tongs was made on time—less than four hours. On the day of our public exhibition, twenty boys worked at the forges about two hours. Practical smiths who were present highly commended their work. Their weakest point was the management of the fire.

Professor Clark wished me to bring some of the wood-work. I could easily have brought a cart-load, but thought it not necessary. The boys do not do fine work, of course, as these few specimens show. I, however, have tracings of the main exercises in wood-work.

As our school has seen but two years, I can not appeal to its graduates to answer the question, "How far is it from our door to positions as journeymen mechanics?" hence, I avail myself of the testimony of Mr. Thomas Foley, instructor of forging, vise-work, and machine-tool work, in the Boston Mechanic Art School. He had himself served an apprenticeship of seven years, and, after several years at his trade, had given instruction for five years. We must consider him a competent judge. In his report to Professor Runkle, and contributed by the latter to the recent report of the Secretary of the Massachusetts Board of Education, Mr. Foley says: "The system of apprenticeship of the present day, as a general rule, amounts to very little for the apprentice, considering the time he must devote to the learning of his trade. He is kept upon such work as will most profit his employer, who thus protects himself. . . . Now, it appears like throwing away two or three years of one's life to attain a knowledge of any business that can be acquired in the short space of twelve or thirteen days by a proper course of instruction." (I take it that by twelve days he means one hundred and twenty hours distributed over about forty days.) "The dexterity that comes from practice can be reached as quickly after the twelve days' instruction as after the two or more years spent as an apprentice under the adverse circumstances mentioned above."

Mr. Foley secures the best results from lessons only three hours long. He adds: "The time is just sufficient to create a vigorous interest without tiring; it also leaves a more lasting impression than by taxing the physical powers for a longer period. We have tried four hours a day, but find that a larger amount of work, and of better quality, can be produced in the three-hour lessons."

I consider this testimony of Mr. Foley very conclusive. It practically disposes of the claim, so often brought forward by practical men, that no boy can learn a trade properly without going to the shop at seven o'clock in the morning and making his day of ten hours, "man-fashion"; and that dirt and drudgery, and hard knocks, and seasons of intense weariness and disgust, even, are essential to the education of a good mechanic.

THE COST.—It remains for me to touch upon the second important question you all have in your minds, namely, that of the cost. You

are practical men and women, and you wish now to sit down and count the cost.

We set out in St. Louis to have the best of everything. We bought the best tools and put in the best furniture. We have plenty of room and light and pure air. We aim to have good teachers and all necessary appliances. Our capacity is about two hundred and forty boys, in three classes of one hundred, eighty, and sixty, in the first-year, second-year, and third-year class respectively.

Our building, complete, cost about	$33,000
Our tools and school-furniture	16,000
If we add the cost of the lot (150 × 106½ feet)	14,400
We have, as the total cost of our plant	$63,400

Where land is cheap, and less or lighter machinery is used, less money would suffice, but let no one deceive himself by supposing that the reform proposed is to be at once a money-saving one. Such a school costs money, but it is a grand investment. Said one of our benefactors to me not ten days ago, "I feel better satisfied with the money I have put into the Manual Training-School than with any other money I have invested in St. Louis."

As to the cost of construction, the shop is about as expensive per hour as the recitation and drawing rooms. Good mechanics, fairly educated, who are at the same time endowed with the divine gift of teaching, are rare. We have a first-class machinist and an expert blacksmith, and pay each twelve hundred dollars per year. The size of our divisions is generally limited to twenty members—in drawing we shall occasionally "double up."

Incidentals—wood, iron, paper, etc.—and the wear and tear of tools amounted last year to about ten dollars per head. The total cost of supplies and instructions and all incidentals, next year, is estimated to be seventy-five dollars per pupil.

How then, say you, can this costly reform be accomplished? The public schools have no funds to spare; salaries are still too low, and the demand for extensions outruns the supply. As Colonel Jacobson, of Chicago, has said: "The alternative before you is more and better education, at great expense, or a still greater amount of money wasted on soldiers and policemen, destruction of property, and stoppage of social machinery. The money which the training would cost will be spent in any event. It would have been money in the pocket of Pittsburg if she could have caught her rioters of July, 1877, at an early period of their career, and trained them, at any expense, just a little beyond the point at which men are likely to burn things promiscuously. It is wiser and better and cheaper to spend our money in training good citizens than in shooting bad ones."

How to go to Work.—There are two ways of going to work:

1. Cut down somewhat, if necessary, the curriculum of higher

studies, and incorporate a manual department with your high-school. The investment will pay, and the means of further growth will soon be found.

2. Mature your plans and lay them before your wealthy, public-spirited men. Almost for the first time in America we are harvesting a splendid crop of millionaires. They abound in every city. They know that boundless wealth left to sons and heirs is often a curse, rarely a blessing, and they would fain put it to the noblest uses. In England such wealth would naturally go to the establishment of noble families, or the purchase of grand estates which should be transmitted unimpaired to the oldest sons through successive generations.

Our American peerage shall consist of those who devote the gains of an honorable career to the establishment of institutions for the better education of generations that shall come after them. Let others follow the example of Cornell, Vanderbilt, and Cooper, of New York; Stevens, of Hoboken; Girard, of Philadelphia; Johns Hopkins, of Baltimore; Case, of Cleveland; Rose, of Terre Haute; the Commercial Club, of Chicago; and those whom I could name in St. Louis.

A NOTE ON "THOUGHT-READING."

By HORATIO DONKIN.

AN article on this subject in the "Nineteenth Century" for June contains conclusions so inadequately supported by trustworthy facts that a few words of comment seem to be called for. The matter in question has attained a somewhat undue prominence of late; but if it is as simple and intelligible as it appears to be to most who have investigated it with care, and with minds free from mystical bias, any aid toward the extinction of what must then be regarded as an *ignis fatuus* of pseudo-science carries with it its own justification.

The position of the writers of the article seems to be that it is possible for one person to divine the thoughts of another in the absence of any *known* means of communication. This inference is based mainly on a series of statements of cases where several children of a certain family, as well as a servant-girl in the same family, were professedly able to tell words and objects thought of in their absence, without contact with or sign from those who knew what they were required to do.

It may be taken as proved that the explanation of *muscular indication* amply covers all cases where, as in the well-known drawing-room game of "Willing," there is actual contact between the person who guides and the person guided. It is difficult, indeed, for the guider, who is intent on the success of the experiment, to avoid giving

hints by pressure, alteration of speed, and otherwise, to the guided one, who is, as a rule, only too ready to quickly interpret them. The same explanation would apply to cases where the person who is "willed" to find something hidden during his or her absence is in no contact with any of the "willing" party, but who often succeeds in discovering the desired object by studying the unconscious indications given by the faces of the expectant circle. All this is, in fact, nearly admitted by the writers we quote, though their denial of Mr. Stuart Cumberland's own explanation of his performances in this line is perhaps as unwarrantable as the "further inquiry" that they suggest.

The remarks in this paper will, therefore, be confined to the alleged results obtained where there was no actual contact. It will be at once admitted with the writers of the article that common sense demands that every known mode of explanation of facts should be exhausted before the possibility of an unknown mode is considered. This is an all-important admission, obvious as it seems to be. It is required by the method of common sense, which is no less the method of science; all true explanation consisting in a procedure from the known to the unknown.

In the next place, it is equally obvious that in all scientific inquiries the good faith of individuals concerned should form no part of the data on which the conclusion is to rest. A person merits credence in proportion as the facts he alleges can be demonstrated or reproduced, and to the jealous care he shows in avoiding fallacy. But we can never, as our authors say, call on Science to put deception out of court by a belief in any one's integrity. Half of the evidence which has propped up the spiritualistic craze is based on the results obtained through mediums of "unblemished character" in private families, whose virtuous reputation has been largely sustained by the fact that they did not take money for their trouble; no regard being paid to innumerable other motives and tendencies to deception.

This being admitted, the cases before us in the paper alluded to can be easily dealt with. They differ in no way from the ordinary platform performances of the little "clairvoyantes" who from time to time have amused us both in the name of Second-Sight and in that of the humbler and honester one of Conjuring. It is well known that a very simple code of signals will suffice to produce results much more startling than those we are discussing. The first word or letter, for instance, of the question asked of the "sensitive" medium may denote the category to which the object fixed upon belongs. The second and third, and so on, serve to specialize it further, and by a series of questions and remarks it is easy to understand that any amount of information may be conveyed. When the clairvoyante is not blindfolded, other means of communication, of course, are possible, and in any case auditory signs other than words could be

agreed upon quite unsuspected by the audience to be amused or deceived.

We have, therefore, an intelligible and admitted explanation which fully serves to cover all the facts in question. Such things are constantly done by collusion—it is a *vera causa.* It would be illogical to substitute for this a perfectly gratuitous hypothesis and an unknown agency. This is especially true in the case of such a set of phenomena as we are now considering. The possibility of thought-reading, as alleged by the writers of the paper, is so far beyond, or rather contrary to, universal experience that some use might fairly be made of the *a priori* argument, although the case need in no way rest on such a method. It may be said in passing that there is an enormous *prima facie* objection to the truth of the proposition that such divination is possible: the assumption and conviction of the contrary, based on immemorial experience, being, as it were, one of the suppressed major premises of all social intercourse.

On this argument, however, we would not depend unduly. The case against the genuineness of the asserted phenomena seems strong enough without it.

The children in question were *not* blindfolded.

In most of the experiments *there is no mention made of silence being preserved.* On the contrary, we may infer that no such rule was made; as the children must have been corrected when their guesses were wrong, as they often were.

On the hypothesis of collusion, it must further be noted that, in order to minimize the difficulty of the code of signals, and simplify the performance as much as possible, the child was previously informed of the nature of the object selected—e. g., whether it was a card or a name. The first guess, then, would give an opportunity for the conveyance of perhaps even the final hint contained in the correction offered.

The mistake made by the *servant* in guessing the name "'Enry" for "Emily" is obviously significant, and an excellent example of an "undesigned coincidence." Surely it must lead almost every plain mind to the irresistible conclusion that a mistaken whisper or facial gesture played some part in the phenomenon. This remark applies as well to the errors made by the children in the case of words alike in *sound.*

The theory of collusion is, moreover, strongly countenanced by the fact of the mediums being children, who are always ready to join in any game of deception; and by the association with them of the servant-girl—a valuable fact, putting out of court the assumption of any inherited special quality peculiar to the family, as an explanation, possibly plausible to some minds, of the alleged marvels.

It will probably, however, be readily allowed, with the authors of the article, that the experiments made in the presence of the members

of the family are scientifically untrustworthy. They may, therefore, be practically ignored. Yet we infer from the paper that most of the experiments were made under these conditions; and we read that the presence of the father "seemed decidedly to increase the percentage of successes."

The authors, indeed, say, "Though generally the object selected was shown to the members of the family present in the room, we were sometimes entirely alone." From the only rational point of view, that of scientific skepticism, and therefore with total disregard of the personal factor, this consideration seems in no way to invalidate the line of comment here taken. It is not clear to how many of the three observers the pronoun "we" in the above passage refers; but, at any rate, we miss entirely in the paper any specific quotation of results obtained in this latter set of circumstances.

But, even if this evidence had been forthcoming, no mere *ipse dixit* on such a matter could for one moment be admitted. Reason would require us to entertain the great probability of mental bias in some at least of the observers, or to discredit the accuracy of their memory, rather than to allow that anything has been adduced in this account of what, to say the least, must be called superficially conducted experiments, to warrant a recognition of any novelty, or, by consequence, to stand in need of explanation by a theory of "brain-waves."—*Nineteenth Century.*

THE PHYSICIAN OF THE FUTURE.*

By Professor GEORGE H. PERKINS.

A CHANGE in the theory of disease, which long since began, but is not yet completed, must profoundly affect the work of the physician of the future. Disease was formerly believed to be a something which had a sort of independent existence, and which went about over the earth seeking whom it might assail. When this something had entered the body of a man it created confusion in his internal economy, and order could not be restored until the intruder was driven out. Accordingly, remedies none of the gentlest were vigorously applied until the disease was scared away or the patient died. It is strange how universal among men this belief in a possession, an entrance of something into the body causing disease, has been.

This savage idea was long perpetuated among civilized people, and remedies were used which were hardly less absurd than the leapings, howlings, and rattle-shakings of an Indian medicine-man. The change

* An Address delivered at the opening of the Twenty-ninth Annual Course of Lectures in the Medical Department of the University of Vermont.

has come very gradually. At first the student of medicine enlarged his field of study, from disease and its phenomena, until it included the structure and action of tissues and organs in health. Physiology and anatomy, of little importance in the old science of medicine, began to have recognized value. After this it was found that organs did not always become disordered because of assaults from within the body, but that they were affected by external influences.

It was found that the organs must not only preserve equilibrium within the body, but that there must also be equilibrium between the body and its externals. It was discovered that in every organ there were forces that built up and forces that pulled down, and that outside of it there were also conservative and destructive forces, and it became obvious that, unless these acted so as to preserve equilibrium, disease, and finally death, must ensue. Thus the art of healing and the science of medicine are now very far from being as simple as they were a century ago, and every year adds to their complexity. The physician of to-day must have full knowledge of man as man, of anatomy and physiology, as a necessary foundation upon which his further studies must rest.

Physiology especially has developed during the last fifty years, so that it has almost become a science by itself, but it still remains a part of the wider science of biology. Here again we see a difference between the studies of the ancient and modern physician. To-day, and still more in the near future, the physician must extend his studies beyond man, and the reason is plain. Man, with whom alone the physician formerly supposed himself concerned, is but an isolated being disconnected from the rest of nature. Nature tolerates no such isolation. No living being, even the simplest, exists, or can exist, independently of other beings. It affects them and is affected by them, and what is true of the simplest is yet more true of the more complex and most of all of man. Nature is one, and all her creatures are parts of the whole. For this reason man can not be fully known merely as man, he must also be known as a part of the animal kingdom. No one can well understand human anatomy or physiology who knows nothing of that of the lower animals. Comparative anatomy and physiology have thrown very much light upon many obscure problems to which the study of man gave rise. Therefore, I would most earnestly urge upon all medical men the study of biology. It may be replied that the courses of study are now crowded, but it is certain that the successful physician of the future *must* know something of nature as a whole. Already many of our most important theories as to disease—the structure of organs, cell-growth, cell-life, and many more—have come to medicine from biology. In an address before the International Medical Congress held in London in August, 1881, Professor Huxley remarks that "the search for the explanation of diseased states in modified cell-life, the discovery of the important part played by parasitic organisms in

the etiology of disease, the elucidation of the action of medicaments by the methods of experimental physiology, appear to me to be the greatest steps which have ever been made toward the establishment of medicine on a scientific basis. I need hardly say, they could not have been made except for the advance of normal biology. There can be no question, then, as to the connection between medicine and biological science. There can be no doubt that the future of pathology, of therapeutics, and therefore of practical medicine, depends upon the extent to which those who occupy themselves with these subjects are trained in the methods and impregnated with the fundamental truths of biology. And I venture to suggest that the collective sagacity of this congress could occupy itself with no more important question than with this: How is medical education to be arranged, so that, without entangling the student in those details of the systematist which are valueless to him, he may be enabled to obtain a firm grasp of the great truths respecting animal and vegetable life without which, notwithstanding all the progress of scientific medicine, he will still find himself an empiric?"

The modern theories of evolution have done great things for medicine, and will do far more in the future. They have put in action forces that may revolutionize medical science. Evolution has shown, as nothing else could, how profoundly animals are affected by their environment, their food, habits, climate, etc., and, by showing how inevitable is the modification of structure in other animals, has called attention to the same facts in man's existence.

Men knew long ago that animals were greatly affected by their surroundings, but this truth was far from being fully recognized until evolution re-affirmed it, and emphasized its affirmation by facts which could not be passed by. Thus man was led to ask, What application have these principles to my own habits of life, to my well-being? To what extent are my diseases induced and fostered by external conditions? The reply to these inquiries is found in sanitary science, in health officers and boards of health, and we have as yet only the beginning of the answer. Sanitary science, though in its infancy, has already profoundly affected medical science in many directions. Perhaps the most important effect that as yet appears is the leading medicine away from its old, blind, absolute faith in remedial agents, in therapeutics, toward greater faith in right living, proper diet, dress, and drainage. Not that remedies are to be wholly laid aside, but they will be more sparingly used, and more intelligently, and often not at all. Where formerly drugs, powerful in quantity and quality, were invariably given, many of our best physicians now prescribe few or none, depending, and with better results, upon pure air, simple food, and other hygienic means. I believe that more would thus treat disease were they not prevented by the patients themselves.

So long as it is less trouble to take quinine than to clear out drain

or cess-pool, so long as men prefer swallowing drugs to abstaining from favorite articles of food, or regulating personal habits, so long must the medical advisers of a community find their best efforts to advance sound sanitary science thwarted. It will be a long and tedious task—this of educating out of the popular mind this strange passion for dosing; but herein lies one of the most important tasks of the physician of the future. If he does his work well, he must be strong enough and determined enough to stem a powerful current of deeply rooted prejudice and self-indulgent unreasonableness; but, if he and his fellows only persevere, they will do incalculable good. So difficult is this work that many shrink from it. They admit the importance of fresh air in hospitals, nay, they demand it, but in their private practice they say little about ventilation. They are careful that their prescriptions shall be properly compounded and regularly taken, but they are much less careful about the diet of their patients. They treat zymotic diseases, but do not enforce such sanitary regulations as they know to be necessary. I do not say that all are open to this charge—not all, but some—and there should be none. With all earnestness would I plead that the people be taught how to live, and I would urge this not only for the sake of the people, but for that of the doctors as well. It is evident that their success as healers of disease must be far greater if their patients observe hygienic laws than if they do not. The instructions of the doctor, weighty enough when given to one stricken with grave disease, may often fall unheeded upon the listless ears of a well person. Sick people are usually more eager to get well than well people to avoid sickness; and yet, even though the labor seem well-nigh useless, the welfare of the race demands that the principles of hygiene be made known, and the task of doing this naturally rests upon those who have undertaken to be the medical advisers of the community. It may be that the people will learn to care very much for those laws upon the observance of which good health depends, with discouraging slowness, but the good work once begun must go on with increasing power and influence. We may take heart as we see what has already been done in this direction, for a great deal of very important knowledge has already been received by the people—knowledge of the necessity for fresh air and sunshine, of cleanliness of person and of premises, of proper food, clothing, and exercise, of the laws of heredity and how hereditary tendencies to disease may be overcome. If we compare the sanitary condition of the homes and the villages of our ancestors not more than a century ago, with that which we may now find, we shall, I think, be led to hope very much for the future. It may still be true, as an eminent medical writer not long since declared it to be, that "men in general behave in relation to the laws which govern human evolution very much as primeval savages behaved in relation to the laws of physical nature—are content with superstition where they should strive to get knowledge, and put up

prayers where they should exert intelligent will." This may be true, but it is certainly less true than formerly, and the physician of the future is to see to it that it becomes wholly untrue. If man can ever reach a time when epidemic diseases shall be of rare occurrence, when all zymotic diseases shall be confined within narrow bounds, and be speedily eradicated within these, he must remember with profound gratitude those to whom he owes his happy estate. Is there any other way in which the physician can so alleviate suffering and so help mankind as by striving to bring to pass such a blessed state of things? Is this too much to hope for? Possibly, but we may approach it much more nearly than we have as yet. Even in its beginning preventive medical science is far from a failure. Epidemic diseases that once raged as the pestilence are now largely prevented; others, once objects of unspeakable terror, are robbed of much of their virulence. Life-insurance statistics show us that human life in England is more than thirty per cent longer to-day than it was one hundred and fifty years ago, and the end is not yet reached.

The relief of suffering, which is commonly thought to be the chief mission of the physician, is indeed a great and noble work, but I believe that he may do a higher and grander work. There are a pathology and a morbid anatomy, not of the body only, but of the moral nature as well. Many physical disorders are also moral and mental, and can only be rightly treated as this is understood. If it be true that men are not only more comfortable and happy when well than when ill, but that they are better morally, a new and most important field of usefulness is opened before the physician. If a well man, other things being equal, is a better man than a sick one, more certain to act wisely, to judge candidly and fairly, and live rightly—if a well man is of more worth in every way than a sick one—then all that has been said of the need and the value of hygienic instruction has added force. I do not for a moment forget the many heroic natures that have been grand enough to rise above bodily pain and feebleness, and with pathetic earnestness have sought to do some good work for the world, and have sent forth from their chambers of suffering golden words, melodious, heart-stirring verses, helpful soul-inspiring thoughts. And yet we need to recognize the fact that good is more certain to come from health than from disease. Pain may have its mission, physical and moral, and may bring out the richness and sweetness of a character as nothing else can, but in and for itself it is not desirable, and it can not be doubted that a community that is sound physically will be more sound morally than it could be if harassed by pain and weakness. I believe that there is such a thing as sin in the world, and I would not call it a disease for which man is not responsible; but none the less do I believe that physical disorder, that sickness and pain, morbid conditions of the body causing morbid conditions of the mind, may and do lie at the foundation of very much that we call crime. A man

whose digestive system is a continual scourge, whose nerves are weak or excited, whose brain receives impure blood, such a man *can* not be the same man morally that he would be were he in full vigor of health. Well men are not always virtuous. Ill health is not the sole cause of crime, nor can criminals be treated as invalids—not at all. And yet crime is often closely connected with disease. It is often both the parent and the offspring of disease. Since we may not know just how much of the crime in the world is due to pathological conditions of the body, we must punish crime as such, but we may, because of our doubt as to its cause, be liberal with our charity and lenient in our judgment whenever, and to such extent, as they may not interfere with the welfare of society as a whole.

No one holds a maniac morally responsible for his actions, even if grossly criminal. Is insanity the only morbid condition that dwarfs man's moral instincts, that blinds him to truth?

In this case we can see how much preventive measures are better than curative, and the future work of the physician, if it be largely the teaching people how to live so that they may avoid disease, must also lessen the amount of crime. It were well if the physician kept constantly before his mind the thought that he is to seek to make men better morally as well as physically. If it is better so to live that illness shall not come, than being ill to be cured, it is also a nobler and a higher task to prevent disease than to heal it, and in this labor of prevention medicine will rise to a height far above that to which it has yet attained, and accomplish results more beneficent and glorious than its greatest triumphs of the past.

And the whole community must be instructed—women more than men, for they more than men regulate the condition of the home. Upon them is laid not only the burden of bearing the children, but they most have to do with their food, clothing, and general training. And, since woman must take part in the great work of sanitary instruction, she should have a thorough medical education, that she may be able to tell to every woman, and every girl too, what she ought to know, and what she will not and can not learn so readily nor so well from any man.

If man were altogether an animal and had only animal instincts, there would perhaps be little ground for hope, but man can be taught not merely that he may so care for his body that it shall be less subject to the attacks of disease, he may be taught that it is his duty to so care for it that his physical organism is a God-given trust which he can not violate without moral wrong. The physician of the future must, as has been already noticed, have to do with the moral as well as the physical nature of man. But, before he can do this with success, he must understand what man is, his feelings, emotions, thoughts, as well as the course of the blood or the action of organs. If he shall know of this higher part of man, he may appeal to it forcibly and

persistently. Anatomists and physiologists, as they study the body, may be so engrossed in the object of their investigations that they forget that it is not the whole of man. They may forget that this dead body which they study does not offer any explanation of the deepest and most conspicuous phenomena of human life and experience. The cadaver on the dissecting-table is not a man. Neither the anatomist's scalpel nor the histologist's microscope can ever discover what it was in that body which made it a man, distinct from other men.

The lips, tongue, vocal cords, are all there, but it was *by* these, not from them, that came the words of love or hate, entreaty or command, which the man spake during his life. The brain is there, it is or was the organ of the mind, but the thought—where is that? Evidently we have not here all that made this man a man, and we must see more than the body if we are to know man; we must see that in that body there was an essence—a something which we can not define, but which is as real as if most definite, and that this something, this soul, is far more important than any other part of man. When he stands over his dissecting-table, the anatomist may think of man as only an aggregation of organs and tissues, and these of differently arranged and modified cells; but when he sends his thought into the recesses of his own heart, when he calls before him the experiences of his inmost life, when he looks around him and sees men—their activities, struggles, defeats, triumphs, courage, even their meanness and knavery, and still more when he knows of their thoughts of the hereafter, their longings for something better and higher than this world can afford them—when, in short, he stands face to face with the phenomena of human life in its varied phases, is he not compelled to believe that it all must have some other source than the molecular and chemical forces which he finds in the body?

It is in this fact—in the existence of a soul in man—that the physician of the future must rest his hope of success. That man has in himself capacity for growth, that progress is and always must be possible to him—these are truths that must sustain the sanitary reformer in the midst of greatest discouragement. If it be true that man may live not only for the present, but as well for the future; if he can be made to see that he may not only make his present life better and nobler, but that in doing this he is affecting his future life; if he can be brought to understand that what he is in this life must necessarily determine largely what he is to be in the life beyond the grave; that, though the body is not the soul, yet, as the medium by which the soul manifests itself, its condition affects the soul—will he not be ready to listen to the teachings of any who can help him to a better physical and so to a better spiritual life? Only as the physician holds before his mind the whole of man can he reach the full development of his own life; only thus can he raise man to that height of sanitary well-

being to which he should seek to raise him. In the address to which reference has already been made, Professor Huxley says: "A scorner of physic once said that Nature and disease may be compared to two men fighting, the doctor to a blind man with a club who strikes into the *mêlée*, sometimes hitting the disease and sometimes hitting Nature. The matter is not mended if you suppose the blind man's hearing to be so acute that he can register every stage of the struggle, and pretty clearly predict how it will end. He had better not meddle at all till his eyes are opened." This predicament of the blind man is probably not unfamiliar to every doctor, for at best human skill and knowledge often reach their limit before the disease does, but certainly every physician should be ready to exert himself to the full extent of his power to open his eyes as far as possible, to be as little blind and as seldom as may be. And as a blind man may be able to prevent a conflict which, once begun, he can not control, so the doctor may have sufficient knowledge to prevent disease which he can not heal. He may often be more certain of his position as a preventer than as a healer of sickness.

Although man stands at the head of creation, it does not necessarily follow that he has reached his highest possible position. It seems entirely reasonable to believe that a more thorough dissemination of sanitary knowledge and its more complete application in common, every-day life would develop a race of men longer-lived, more vigorous, happier, and better than any yet seen. It may be too late to do very much with this generation, but may there not be hope for the next, and the next after that? What might not a few generations of right living, right feeling, right thinking men do for the race? Here, then, are opportunities within the grasp of the physician of the future such as await no one else—opportunities for useful, helpful work such as never before inspired the mind or stirred the heart of the professional student; such a privilege of effectually aiding in the advancement of the human race, of making it nobler and better.

Such opportunities well used must bring upon those to whom they are given a glorious benediction.

It should not escape the notice of the physician that this golden future will not inevitably be his to whom by right it belongs. By right, if he seizes it and holds it; but, if he does not, it must slip from him, as it should. Already many of the leaders in sanitary movements are not from among medical men. These, many of them, fail to appreciate their privilege; they do not see what is before them, but are so busily engaged in search of some pill or potion which may or which may not cure some disease, that they can not see the treasure which lies just within reach. The whole work of medicine is important, and the search after remedies should not be abandoned as useless, neither should it take the place of greater and more important labors. It is a noble thing to give time and strength to the discovery of means

which may be used to heal disease or alleviate pain, but it is a far grander and nobler task to teach the people how to live so that disease and pain will not come upon them.

TRIALS BY FIRE AND FIRE-JUGGLERS.

By M. A. De ROCHAS.

IN his very interesting lecture on witches, Dr. Regnard has mentioned that insensibility to suffering was, in the middle ages, considered evidence of diabolical relations. By a singular contradiction of the human mind, this same insensibility was also under certain circumstances attributed to divine intervention; and that which, in one case, brought death upon the accused, was good for his acquittal in another case.

Trial by fire, by means of which Heaven was appealed to for proof of innocence, appears to have originated in India. The Vedas mention it, and travelers still find it in use in all the East. The Greeks also were acquainted with it. "We are ready to hold red-hot iron and walk through flames to prove our innocence!" exclaimed the Thebans in the "Antigone" of Sophocles, who were accused of having abetted in the theft of the body of Polynice.

The first authentic trial of this kind recorded among Christians is related by Gregory of Tours, in the case of Saint Sulpicius, Bishop of Autun. This saint, who lived in the fourth century, was made a bishop, although he was married. His wife could not make up her mind to leave him, but resolved to live with him under a vow of chastity taken according to the laws of the Church. Having learned that the faithful accused them of not observing their vow, the woman had fire brought to her publicly on Christmas-day, and, having held it in her dress for nearly an hour, gave it to the bishop, saying to him, "Take this fire, which will not burn you, so that they may see that the fire of lust has no more effect upon us than these coals have upon our clothes."

Saint Brice, Bishop of Tours, made use of a similar trial to prove his innocence of a crime that was imputed to him. The chronicles, beginning from this epoch, have preserved numerous examples of these trials. They were employed, not only to discover heretics, but also to distinguish genuine relics from false ones. The Council of Saragossa, in 592, ordered that only those relics which the fire had respected should be venerated. The multiplication of these trials in Gaul was probably due to the influence of the conquering race, with whom the custom seems to have been established from time immemorial. In an addition to the Salic law made by Kings Childebert and

Clotaire, in 593, was a clause that a man, accused of theft, should be adjudged guilty of it if he was burned in the trial by fire. In 630 King Dagobert, in reforming the laws of the Bavarians, the Alemans, and the Ripuarians, according to Christian ideas, continued in effect the law of the Ripuarians providing that, if any one was cited before a court to answer for an offense by his servant, he should be adjudged guilty if the hand of his servant was hurt by the fire. In 819 Louis le Débonnaire ordained that a servant, who was burned in the trial by boiling water, should be put to death. Hincmar relates that Queen Thietberge, wife of King Lothair, when accused of a horrible offense, proved her innocence by a man who underwent for her in 860 the trial by boiling water without being scalded. In 876, Louis, second son of Louis the German, established his rights over Germany, which his uncle, Charles the Bald, contested, by means of thirty men, ten of whom suffered the trial by cold water, ten that of hot water, and ten that of red-hot iron. Charles the Bald, not willing to give up to these proofs, marched against his nephew at the head of an army, and was thoroughly beaten. It would be superfluous to multiply examples of this kind, which became more and more numerous till the end of the eleventh century, when the trials were formally condemned by Popes Stephen V, Celestine III, Innocent III, and Honorius III.

We pass on to the description of the general course of proceeding: Trial by hot water was made simply by plunging the arm into a boiler full of boiling water, to take out from it a ring, or a nail, or a stone, which had been suspended in it. In some causes the hand was put in to the wrist, in others to the elbow. It is even said, in the formulas of Saint Dunstan, that the stone was sometimes concealed under an ell-deep of hot water. Commoners made the trial for themselves, while people of quality hired others to make them. Those who were burned were declared guilty, and those who escaped were considered innocent.

The trial with hot iron, called judgment by fire, was made in different ways. Sometimes one red-hot iron was taken hold of—or perhaps several in succession—and was carried to a considerable distance. The iron was generally shaped like a plowshare, and was, therefore, called *Vomer*. A second way was to walk upon red-hot irons with the legs bare to the knee. Six, nine, or twelve irons were made ready for the trial, according to the magnitude of the imputed offense. In Denmark a kind of red-hot iron glove, reaching to the elbow, was used.

The trials were made in the presence of priests delegated by the bishop, and of secular officers of justice. Those who submitted to them were obliged first to wash their hands, arms, or feet, with fresh water, to remove any advantages they might have obtained from rubbing their limbs with some substance that could deaden the action of

the fire; the priest then threw holy water upon them, pronounced exorcisms and benedictions, which may be found in the formulas of Marculfe and Saint Dunstan, made them kiss the Gospels, and then the trial began. When it was over, the hand, arm, or foot that had been in contact with the fire was wrapped in a linen cloth, under the seal of the judge, not to be opened till after three days had passed.*

It is not easy to give now a natural explanation for all of these facts; we are too little informed respecting the accompanying circumstances. It appears, however, that we might, besides having recourse to the cases of hysterical insensibility described by Dr. Regnard, connect the power of enduring the trials with one of the three following causes: diminution of the sensation of heat by evaporation from the surface of the skin; insensibility obtained for the skin by means of preliminary artifices; and illusion respecting the intensity of the source of heat.

With respect to the first of these causes, the experiments of M. Boutigny are well known; and it is possibly only the want of hardiness that prevents our discovering more numerous applications of it. Dr. Davenport, an English physician, gives one of them. He says he has seen a workman in the dock-yards at Chatham plunge his bare hand into boiling pitch. The man tucked up his shirt-sleeve, put in

* [A volume of the "Calendars of State Papers; Colonial Series," recently published in London, under the editorial supervision of W. Noel Sainsbury, of the Public Record Office, contains in a letter of 1620, from an agent of the East India Company, in the Island of Tecoe, a description of the native rite of purgation from the charge of murder, which closely resembles the Saxon ordeal. The account is the more valuable and interesting, because it is, to all appearance, authentic, and not tainted with the superstitious credulity with which the stories dating from the middle ages are colored. An Englishman having been killed by some of the islanders, Nicolls, the chief factor, obtained their king's license to summon the suspected persons and make them touch the corpse. All except one, who was ill, obeyed the summons, but betrayed no sign of guilt; whereupon the king ordered the absentee to be sent for. "He took," says the narrator, "the dead man by the hand with extreme quaking and many distracted gestures and answers, but would not hold it any time. Nicolls urged this to be the man, and required justice. The king caused him to be bound, and professed in his conscience that he was the man, but that he must be tried by their law also. . . . A fire was made, and an iron pan with a gallon of oil set to boil, till it came to such a degree of heat that a green leaf dipped therein was sodden and shriveled. The prisoner was then, in testimony of his innocence, to take a small ball of brass, little bigger than a musket-shot, out of the oil with his naked hand, and if any burning or scald appeared thereon he was contented to die. . . . Stripping up his sleeve above the elbow, and taking a kind of protestation, desiring that as he was clear he might prosper in this act, he dipped his hand to the wrist in the boiling oil, took out the ball, held it fast, and crying '*Olla Basar!*' ('Great is the Lord!'), tossed it up, caught it again, and then cast it on the ground, showing his hand, which had no more sign of hurt than if he had experimented the same in cold water; the devil, as seems, being loath at that time to lose his credit. The fellow was instantly released, and within an hour after returned in his holiday apparel, and none so lusty as he, though so weak before as to be brought upon men's shoulders to his trial. This was all the justice we could have for our murdered man."—Editor P. S. M.]

his hand up to his wrist, and took out some of the pitch as he would have done with a spoon; the pitch, which was in actual contact with his skin, he wiped off with tow. To assure himself that there was no trickery, Dr. Davenport put his whole forefinger into the boiling pitch, and was able to move it about for some time before the heat became uncomfortable. The workman affirmed that, if any one put his hand when covered with a glove into the boiling liquid, he would be burned very badly. A fact related by Dr. Beckman, another physician, is referable to both the first and the second of the causes we have mentioned. A workman in the foundry at Auerstädt, in 1765, for a small gift, took some melted copper in the hollow of his hand, showed it to the spectators, and then threw it against the wall. Then he rubbed the fingers of his calloused hand briskly together, put them under his armpits for a few instants, to make them sweat, as he said, passed them over a dish of melted copper as if he would skim it, and finished by moving his hand rapidly backward and forward in the liquid mass. Dr. Beckman perceived a strong smell of burned horn while this was going on, but the man's hand did not seem to be hurt.

In 1809 a Spaniard named Lionetto went through Europe performing still more wonderful feats. While he was at Naples he excited the curiosity of Professor Sementini, who made a study of him, and, having performed numerous experiments upon himself, has left us the most positive documents that we possess on the subject. Lionetto put a plate of red-hot iron on his hair, and a thick fume was immediately seen to rise from it. He struck his toes with another red-hot iron, and this likewise produced a thick and offensive vapor. He put an iron nearly red-hot between his teeth. He drank about a third of a spoonful of boiling oil. He quickly plunged the ends of his fingers into melted lead, and put a little of the liquid metal on his tongue; and afterward he bore a red-hot iron upon that organ, which was covered with a grayish coating. Professor Sementini discovered: 1. That rubbings with sulphuric acid leave the skin insensible to red-hot iron. 2. That a more complete result is reached by rubbing with a solution of alum evaporated till it becomes spongy. 3. That the insensibility obtained by either of these processes is made considerably more perfect by a series of rubbings with hard soap, each rubbing, except the last one, being followed by washing with water. 4. That the tongue may be made insensible by covering it with a salve composed of a solution of alum saturated at the boiling-point. Boiling oil put on a tongue thus prepared did not burn it; a hissing was produced, like that of hot iron when put into water; the heated oil cooled in contact with the solution, and could then be swallowed without danger.

Professor Sementini remarks that Lionetto, to satisfy the spectators that the oil was really hot, threw lead into it, which melted, but that the lead, in melting, absorbed a part of the heat from the oil. It is very possible, also, that the jugglers, instead of melted lead, used

alloys fusible at low temperatures, or even simply mercury, as is done in some imitations of their tricks.

A father in the Church, Saint Hippolytus, has revealed to us in a book called "Philosophumena" other tricks which the pagan priests employed. "This is the way," he says, "that the magician can put his hand into a brass vessel full of pitch that appears to be boiling. He puts into the dish vinegar and natron (carbonate of soda), and, on top of this liquid, pitch. The mixture of vinegar and natron has the property, on the application of the slightest heat, of agitating the pitch and producing bubbles that rise to the surface and present the appearance of boiling. Previous to the operation, he washes his hands several times with salt-water, which would keep them from getting burned even if the pitch should be really hot. If he anoints his hands with myrtle, natron, and myrrh mixed with vinegar, and washes them as well with salt-water, he will not be burned. His feet will not be burned if he anoints them with isinglass.

"The magician breathes fire and smoke from his mouth; then, putting a piece of cloth on a dish full of water, he throws burning coals upon it, and they leave the cloth intact.

"He breathes smoke from his mouth for a short time, by putting in it a coal of fire wrapped in tow, and keeping the coal alive with his breath. The cloth in the dish is kept from being set on fire by the coals that are thrown upon it, by the transfer of the heat to the salt-water under it. The cloth should also be previously dipped in salt-water and covered with a mixture of whites of eggs and liquid alum. If to this liquid we add the liquor of eternal life,* the effect of the composition is to render the cloth—providing it has been prepared for some time—wholly incombustible."

We may remark upon the similarity of the last recipe with that which the latest experiments have suggested for the robes of ballet-dancers in the opera.

The feat of breathing fire played an important part in antiquity. By its aid the Syrian Eunus was able to revive the insurrection of the slaves in Sicily, and Barchochebas to assume the command of the Jews who revolted against Hadrian. Both used it to make their followers believe in the divine inspiration with which they pretended to be invested, the former by the Syrian goddess, the latter by the God of Israel.

I give next one of the recipes of the jugglers who at present perform this miracle in the fairs. They take a handful of tow in each hand; the left hand holds also, concealed, a piece of burning tinder. The performers begin by taking from the right hand with the teeth a piece of tow which they pretend to chew, while they fill it with saliva and dispose it in the mouth, by the aid of the tongue, so as to form a

* Possibly ammoniacal carbonate of copper, the magnificent color of which is called by chemists celestial blue. The ancients got ammonia by distilling blood with ashes.

kind of shield against the heat. Then, pretending to take new tow with the left hand, they introduce into the mouth the parcel of inflamed tinder, on which they immediately place dry tow by biting into the right handful. Combustion is excited by blowing with the throat, and the current of air protects the lips from burning.

I have repeated the experiment of a pretended boiling described in the "Philosophumena," using oil instead of liquid pitch. It produced a complete illusion. The oil boiled in large bubbles, throwing up to the surface a white foam, without its being necessary to raise the temperature to more than 86°.

I have not tried either of the processes for producing insensibility described above, nor those which are given by Albertus Magnus and other sorcerers of the middle ages, as follows:

"1. Take mallows-juice, powdered psillium-seed, and lime; mix the whole with the white of an egg and horse-radish-juice. Rub the hands with the mixture and let them dry; then rub them again, and you will be able to handle fire.

"2. Dissolve quicklime in bean-water, then mix in Messina earth, to which add a little mallows and bird-lime; rub yourself with it and let it dry.

"3. Rub your hands with strong vinegar in which you have dissolved vitriol, and add plantain-juice."

It was probably by the aid of similar recipes that the priestesses of Diana Parasya, in Cappadocia, according to Strabo, were able to walk barefooted over burning coals; and the Hirpi, according to Pliny, procured exemption from military service by renewing the same miracle annually in the Temple of Apollo, on Mount Soracte. In our own time the Arabian sect of the Aissaouas perform feats quite as astonishing as those we have mentioned. The subject might afford entertaining studies to those who are interested in finding natural ways of accounting for facts which have been regarded as prodigies.—*Revue Scientifique.*

ELECTROMANIA.

By W. MATTIEU WILLIAMS.

A HISTORY of electricity, in order to be complete, must include two distinct and very different subjects: the history of electrical science, and a history of electrical exaggerations and delusions. The progress of the first has been followed by a crop of the second from the time when Kleist, Muschenbroek, and Cuneus endeavored to bottle the supposed fluid, and in the course of these attempts stumbled upon the "Leyden-jar."

Dr. Lieberkuhn, of Berlin, describes the startling results which he

obtained, or imagined, "when a nail or a piece of brass wire is put into a small apothecary's phial and electrified." He says that "if, while it is electrifying, I put my finger or a piece of gold which I hold in my hand to the nail, I receive a shock which stuns my arms and shoulders." At about the same date (the middle of the last century), Muschenbroek stated, in a letter to Réaumur, that, on taking a shock from a thin glass bowl, "he felt himself struck in his arms, shoulders, and breast, so that he lost his breath, and was two days before he recovered from the effects of the blow and the terror"; and that he "would not take a second shock for the kingdom of France." From the description of the apparatus, it is evident that this dreadful shock was no stronger than many of us have taken scores of times for fun, and have given to our school-fellows when we became the proud possessors of our first electrical machine.

Conjurers, mountebanks, itinerant quacks, and other adventurers operated throughout Europe, and were found at every country fair and *fête* displaying the wonders of the invisible agent by giving shocks and professing to cure all imaginable ailments. Then came the discoveries of Galvani and Volta, followed by the demonstrations of Galvani's nephew Aldini, whereby dead animals were made to display the movements of life, not only by the electricity of the voltaic pile, but, as Aldini especially showed, by a transfer of the mysterious agency from one animal to another. According to his experiments (that seem to be forgotten by modern electricians), the galvanometer of the period, a prepared frog, could be made to kick by connecting its nerve and muscle with muscle and nerve of a recently killed ox, with or without metallic intervention.

Thus arose the dogma which still survives in the advertisements of electrical quacks, that "electricity is life," and the possibility of reviving the dead was believed by many. Executed criminals were in active demand; their bodies were expeditiously transferred from the gallows or scaffold to the operating-table, and their dead limbs were made to struggle and plunge, their eyeballs to roll, and their features to perpetrate the most horrible contortions by connecting nerves with one pole, and muscles with the opposite pole of a battery.

The heart was made to beat, and many men of eminence supposed that if this could be combined with artificial respiration, and kept up for a while, the victim of the hangman might be restored, provided the neck was not broken. Curious tales were loudly whispered concerning gentle hangings and strange doings at Dr. Brookes's, in Leicester Square, and at the Hunterian Museum, in Windmill Street, now flourishing as "The Café de l'Étoile." When a child, I lived about midway between these celebrated schools of practical anatomy, and well remember the tales of horror that were recounted concerning them. When Bishop and Williams (no relation to the writer) were hanged for burking, i. e., murdering people in order to provide "sub-

jects" for dissection, their bodies were sent to Windmill Street, and the popular notion was that, being old and faithful servants of the doctors, they were galvanized to life, and again set up in their old business.

It is amusing to read some of the treatises on medical galvanism that were published at about this period, and contrast their positive statements of cures effected and results anticipated with the position now attained by electricity as a curative agent. Then came the brilliant discoveries of Faraday, Ampère, etc., demonstrating the relations between electricity and magnetism, and immediately following them a multitude of patents for electro-motors, and wild dreams of superseding steam-engines by magneto-electric machinery.

The following, which I copy from "The Penny Mechanic," of June 10, 1837, is curious, and very instructive to those who think of investing in any of the electric-power companies of to-day: "Mr. Thomas Davenport, a Vermont blacksmith, has discovered a mode of applying magnetic and electro-magnetic power, which we have good ground for believing will be of immense importance to the world." This announcement is followed by reference to Professor Silliman's "American Journal of Science and the Arts," for April, 1837, and extracts from American papers, of which the following is a specimen: "1. We saw a small cylindrical battery, about nine inches in length, three or four in diameter, produce a magnetic power of about three hundred pounds, and which, therefore, we could not move with our utmost strength. 2. We saw a small wheel, five and a half inches in diameter, performing more than six hundred revolutions in a minute, and lift a weight of twenty-four pounds one foot per minute, from the power of a battery of still smaller dimensions. 3. We saw a model of a locomotive-engine traveling on a circular railroad with immense velocity, and rapidly ascending an inclined plane of far greater elevation than any hitherto ascended by steam-power. And these and various other experiments which we saw convinced us of the truth of the opinion expressed by Professors Silliman, Renwick, and others, that the power of machinery may be increased from this source beyond any assignable limit. It is computed by these learned men that a circular galvanic battery about three feet in diameter, with magnets of a proportionable surface, would produce at least a hundred horse-power; and therefore that two such batteries would be sufficient to propel ships of the largest class across the Atlantic. The only materials required to generate and continue this power for such a voyage would be a few thin sheets of copper and zinc, and a few gallons of mineral water."

The Faure Accumulator is but a very weak affair compared with this, Sir William Thomson notwithstanding. To render the date of the above fully appreciable, I may note that three months later the magazine from which it is quoted was illustrated with a picture of the

London and Birmingham Railway Station, displaying a first-class passenger with a box-seat on the roof of the carriage, and followed by an account of the trip to Boxmoor, the first installment of the London and Northwestern Railway. It tells us that, "the time of starting having arrived, the doors of the carriages are closed, and, by the assistance of the conductors, the train is moved on a short distance toward the first bridge, where it is met by an engine, which conducts it up the inclined plane as far as Chalk Farm. Between the canal and this spot stands the station-house for the engines; here, also, are fixed the engines which are to be employed in drawing the carriages up the inclined plane from Euston Square, by a rope upward of a mile in length, the cost of which was upward of £400." After describing the next change of engines, in the same matter-of-course way as the changing of stage-coach horses, the narrative proceeds to say that "entering the tunnel from broad daylight to perfect darkness has an exceedingly novel effect."

I make these parallel quotations for the benefit of those who imagine that electricity is making such vastly greater strides than other sources of power. I well remember making this journey to Boxmoor, and four or five years later traveling on a circular electro-magnetic railway. Comparing that electric railway with those now exhibiting, and comparing the Boxmoor trip with the present work of the London and Northwestern Railway, I have no hesitation in affirming that the rate of progress in electro-locomotion during the last forty years has been far smaller than that of steam.

The leading fallacy which is urging the electro-maniacs of the present time to their ruinous investments is the idea that electro-motors are novelties, and that electric-lighting is in its infancy; while gas-lighting is regarded as an old or mature middle-aged business, and therefore we are to expect a marvelous growth of the infant and no further progress of the adult. These excited speculators do not appear to be aware of the fact that electric-lighting is older than gas-lighting; that Sir Humphry Davy exhibited the electric light in Albemarle Street, while London was still dimly lighted by oil-lamps, and long before gas-lighting was attempted anywhere. The lamp used by Sir Humphry Davy at the Royal Institution, at the beginning of the present century, was an arrangement of two carbon pencils, between which was formed the "electric arc" by the intensely vivid incandescence and combustion of the particles of carbon passing between the solid carbon electrodes. The light exhibited by Davy was incomparably more brilliant than anything that has been lately shown either in London, or Paris, or at Sydenham. His arc was *four inches in length*, the carbon pencils were four inches apart, and a broad, dazzling arch of light bridged the whole space between. The modern arc-lights are but pygmies, mere specs, compared with this, a leap of one eighth or one quarter inch constituting their maximum achievement.

Comparing the actual progress of gas and electric lighting, the gas has achieved by far the greater strides; and this is the case even when we compare very recent progress. The improvements connected with gas-making have been steadily progressive; scarcely a year has passed from the date of Murdoch's efforts to the present time, without some or many decided steps having been made. The progress of electric-lighting has been a series of spasmodic leaps, backward as well as forward. As an example of stepping backward, I may refer to what the newspapers have described as the "discoveries" of Mr. Edison, or the use of an incandescent wire, or stick, or sheet of platinum, or platino-iridium; or a thread of carbon, of which the "Swan" and other modern lights are rival modifications.

As far back as 1846 I was engaged in making apparatus and experiments for the purpose of turning to practical account "King's patent electric light," the actual inventor of which was a young American, named Starr, who died in 1847, when about twenty-five years of age, a victim of overwork and disappointment in his efforts to perfect this invention and a magneto-electric machine, intended to supply the power in accordance with some of the "latest improvements" of 1881 and 1882. I had a share in this venture, and was very enthusiastic until after I had become practically acquainted with the subject. We had no difficulty in obtaining a splendid and perfectly steady light, better than any that are shown at the Crystal Palace. We used platinum, and alloys of platinum and iridium, abandoned them as Edison did more than thirty years later, and then tried a multitude of forms of carbon, including that which constitutes the last "discovery" of Mr. Edison, viz., burned cane. Starr tried this on theoretical grounds, because cane being coated with silica, he predicted that by charring it we should obtain a more compact stick or thread, as the fusion of the silica would hold the carbon-particles together. He finally abandoned this and all the rest in favor of the hard deposit of carbon which lines the inside of gas-retorts, some specimens of which we found to be so hard that we required a lapidary's wheel to cut them into the thin sticks.

Our final wick was a piece of this of square section, and about one eighth of an inch across each way. It was mounted between two forceps—one holding each end, and thus leaving a clear half-inch between. The forceps were soldered to platinum wires, one of which passed upward through the top of the barometer-tube, expanded into a lamp-glass at its upper part. This wire was sealed to the glass as it passed through. The lower wire passed down the middle of the tube. The tube was filled with mercury and inverted over a cup of mercury. Being thirty inches long up to the bottom of the expanded portion, or lamp-globe, the mercury fell below this and left a Torricellian vacuum there. One pole of the battery, or dynamo-machine, was connected with the mercury in the cup, and the other with the upper wire. The

stick of carbon glowed brilliantly, and with perfect steadiness. I subsequently exhibited this apparatus in the Town-Hall of Birmingham, and many times at the Midland Institute. The only scientific difficulty connected with this arrangement was that due to a slight volatilization of the carbon, and its deposition as a brown film upon the lamp-glass; but this difficulty is not insuperable.—*Knowledge.*

ANTHROPOID MYTHOLOGY.

By Dr. B. PLACZEK.

SHAKESPEARE in one place calls sleep the "ape of death," and thereby gives living expression to an idea which men have at all times entertained of their "nearest relative." As sleep to death, so according to the vulgar view is the ape related to man. Sleep is not quite death, and is no longer conscious life, but is something between the two; and man learns to regard it as a counterfeit of death. We may say, in general, that wherever men have come into close contact with monkeys they have acquired the same impression of them, that they are a caricature of man, and the idea that they are a not-yet man or a no-longer man, a human likeness of a more primitive design or one that has suffered deformity. All of the more ancient conceptions of the relations between men and apes thus waver between variation and degeneration. The shape which the idea of a community of the two principal families of primates has taken, among the partisans of creation as well as of transformism, can be followed, from divination to empiricism, from superstition to scientific description, and it is not strange that among all the theories of the doctrine of development the so-called "monkey theory" has spread most rapidly and widely. Besides the myths and legends in which the face of an ape now and then appears—fables, the fundamental idea of which carried out by skillful and careful minds assumes a scientific value—we meet, among the more ancient peoples who made the anthropoid apes the subjects of scientific disputes or invested them with religious or ritual interest, far more important expressions of a supposed relationship of those creatures with man.

The most ancient literature of the Hebrews is eminently a rich and inexhaustible treasury of observations of nature and inquiries into it. We shall first concern ourselves with these, and then draw from Arabian, Egyptian, Indian, ancient Mexican, and other stores, their ape-lore so far as it is of scientific interest and approaches the present conceptions of the nature of apes. Of the joint triennial voyages of the Israelite and Phœnician fleets to Africa, 1 Kings x, 22, says: "For the king had at sea a navy of Tarshish with the navy of Hiram;

once in three years came the navy of Tarshish, bringing gold and silver, and ivory, and apes, and peacocks." This is repeated in 2 Chronicles ix, 21. The joint expeditions to Ophir referred to in 1 Kings ix, 27, 28, x and xi, and in 2 Chronicles ix, 10, were probably of the same kind. The name of Tarshish (Tartessus in Spain), the most important trading-point of the Phœnicians, had probably come into application to designate all large merchant-vessels designed for long sea-voyages, in whatever direction they might be accustomed to sail. The Hebrew names for apes, *kofim* (singular *kof*), and peacocks, *tukijim*, undoubtedly point to an Indian derivation. For *kof*, ape, is in Sanskrit *kafi*, "the nimble," and *tukij* corresponds with the Malabar *tógai*. The apes which the sailors of those times brought back from their distant journeys were probably Asiatic, even if the possibility is not excluded that the Israelite-Phœnician ships occasionally touched the African coasts and brought monkeys thence. That different kinds of monkeys were kept by the ancient Hebrews as pets, and were also trained for employment in household tasks, appears in numerous places in the post-Biblical literature. Four kinds of monkeys were particularly mentioned: *kof*, the ape in general, where it alone is named; when it appears at the same time with others it perhaps refers to the Indian *Hanuman* (*Semnopithecus entellus*); *kipud* or *kipuph* (regarded by some commentators as an abbreviation of cercopithecus), a tailed ape or baboon; *Adne-hasadeh*, or *Abne-hasadeh*, or *Adam-hasadeh* (according to Bochart), or *Bar-nash-ditur*, corresponding with the orang-outang or the anthropoid apes; and *Delphik*. Everywhere is a relationship of the ape with man suggested, and in the ritual casuistics the ape is regarded as a kind of man, and so considered in view of the religious law. At the sight of an ape or a monkey, the benediction was uttered, "Praised be he who changes his creatures!"—an allusion to the belief which was found among many ancient people, especially among the Arabs, that the ape was a degenerated form of man, or that the latter took on the outward appearance of the ape in consequence of moral degeneration (Talmud, B. Berachoth, 58 b.). But since the ape to which the benediction applies is placed in the same category with a negro, albino, or dwarf, the idea appears to underlie it that the variation is an inborn one. The former acceptation is supported in Berachoth 57 b., "To see an ape or a monkey in a dream is a bad sign"; and in Bereschit Rabba C., 23, "In the time of Enoch men were changed into apes." Rabbi Jose taught that the corpse of an Adne-hasadeh was unclean in the tent the same as that of a man, while the laws in the case of the bodies of beasts were quite different. Immediately afterward the same Rabbi Jose expresses the opinion that the ape (*kof*) must be regarded as an undomesticable or hardly domesticable animal. According to him, the Adne-hasadeh stands much nearer to man than the common ape or than any other tailed species of ape. It appears from Joma 29 b and Menachot 100 b, that the ape

was employed in household tasks: "If the show-bread is not arranged according to the directions upon the holy tables in the temple at Jerusalem, it is just as though an ape had done it.", According to Idajim, 1, 5, the ape could be employed in connection with certain religious ablutions; but the Rabbi Jose, named above, denies him this property. Baba Kama speaks of apes being trained to keep the house clear of vermin; and it is well known that they will eat the smaller animals, such as young birds, mice, bugs, and caterpillars, as dainties.

Of the tricks of apes, Baba Kama tells of one of the animals that stole dye-stuff and colored wool with it. Nedarim mentions one that ran away and was found in a cave along with the treasures that it had collected there. Duvaucel, Brehm, and others, say that Indian apes steal and conceal gold, precious stones, and other bright things.

The palatableness of the milk and blood of bipeds is spoken of by several Talmudic authors, and the question is suggested why, if only men are meant, the term biped should be exceptionally used. The glossater, A. ben David, adds the remark, "such as man"; while Jizchaki says, "Only man is meant here." The erect anthropoids may, however, also have been in the thought of the writers. In exposition of Leviticus xi, 27, "And whatsoever goeth upon his paws, among all manner of beasts that go on all four," it is remarked in the Sifra, 51, "By these are meant the ape (*kof*), the *Kipud*, and *Adnehasadeh*." A. ben David says in this connection: "While the ape resembles man in form, and has fingers on his hands and toes on his feet like men, he is nevertheless ranked among the other animals as unclean." In Jebamot, it is said that a deformity of a man's foot by which the toes are bent under the sole so that he has to walk on the back of his foot, renders him unfit for the performance of certain ceremonies. In Moëd Katon is an allusion to a funeral orator, named Bar Kipuph (son of an ape or ape-man), who had a deformity of this kind, and probably received his nickname in consequence of it. Robert Hartmann says that the chimpanzee and orang-outang go on all-fours, bending their fingers into the hollow of their hands, and setting the calloused back of their hands on the ground; and this explains why the gait of crippled persons was called ape-like, and why the orator was called Bar Kipuph. Sometimes we meet the expression, "like the act of an ape," a bare imitation.

The fables of the *Abne*, *Adne*, or *Adone-hasadeh*, have assumed very strange forms. While the Talmudic and Midraist representations of this being distinctly point to an authropoid ape, the name of which may appear in Job v, 23—"For thou shalt be in league with the stones of the field; and the beasts of the field shall be at peace with thee"—where the word in the original translated stones is believed by some to refer more properly to this animal—the interpreters and glossaters, following the fashion of the grotesque fables of great apes, have made a formidable monster of it. Kilajim describes it as the

Bar-nash-ditur (man of the mountain), which can live only through the umbilical cord, and dies if it is broken. Maimonides says the Adone-hasadeh are animals resembling men. Travelers wrote of the animal that it talked much and intelligently, even with a human articulation. In Arabic it is called *alnanas*, which Buxdorf translated *νάνος*, nanos, dwarf (in Talmudic *nanos* means shut). Clearness is lent to the supposition that these accounts referred to apes by the fact that E. Tison, in 1698, methodically dissected a female chimpanzee from Angola in Africa, and called it a pygmy, comparing it with the accounts of the ancients respecting alleged dwarf races in Ethiopia, which races, however, modern ethnologists recognize in several real living tribes of diminutive size. Simson asserts in a note to Kilajim, 8, 5, that he had heard that the Abne-hasadeh was the animal *Jodua*, through a bone of which, according to Talmud Synhedrin 65, a, b, the wizards mentioned in Leviticus xix, 31, and xx, 6, and in Deuteronomy xviii, 11, placing them in their mouths, were able to prophesy; "and how a great cord rises out of a root in the ground on which the Jodua grows like a squash or melon; his face, body, and limbs are like those of a man, but the navel is joined to the cord that rises out of the earth-root. No being dare venture within reach of the cord, for fear of being destroyed, and the animal devastates everything within the circle which the cord describes. No man can approach it with safety; and, if any one wishes to overcome it, he must endeavor to lay hold of the cord and break it, or shoot through it from a distance with an arrow, when the animal dies." We apparently have to deal here with a conglomeration of fables of different times and places. There are, first, exaggerations in the sketches of the great anthropoid apes, from Hanno in his *periplus* to the fanciful Du Chaillu, not to speak of the fabulous impossible accounts that appear in Pliny, Ælian, and other ancient writers. The Adne-hasadeh, or Jodua, except as to the navel-cord, corresponds well with the authentic accounts of the gorilla as we find them in the works of Brehm, Dr. Franquet, R. Burton, Lenz, Gürsfeld, and Koppenfels. By means of the navel-cord we may recognize in the Adne-hasadeh a plant-animal, a kind of *Boranetz*, of the fable of which Lewysohn, in his "Biology," introduces the following account: "In this steppe or desert (Lesser and Great Tartary) is found the Boranetz, or Bornitch, as some call it, a fruit as large as a melon, having the form of a sheep (whence it gets the name of Boran, Russian for *sheep*), with a head, feet, and snout, and, what is remarkable, this fruit has on the outside a skin covered with white, bright, and very finely tinted hair, firm as silk. These skins are valued very highly by the Tartars and Russians. This Boranetz grows on a bush three feet high, which implants itself in the navel of the sheep. The fruit turns, like a summer flower, as if it would incline itself toward the plants near it. They tell of it, that if the grass and plants around it dry up, the fruit perishes for want of food and support; and the same

happens if the surrounding vegetation is cut and taken away green. They say also that wolves are very fond of the Boranetz, and that it has within meat, blood, and bones." The Adne-hasadeh has, however, none of the lamb-like character of the Boranetz, but, on the contrary, a spirit averse to restraint.

I believe a slight etymological rectification will give us a clew to the conception out of which this fable has grown. For *tabur*, navel, substitute *tabaat*, fundament, and from the cord connecting the navel with a root in the ground we are led to the tail, by which the animal hangs itself to a limb or a projecting root. The accounts of the ferocity of the Adne-hasadeh need not be rejected as silly and monstrous when we recollect how mischievous and destructive some apes are, as, for instance, the *Cynocephalus sphynx*, which may have stood for the original Adne-hasadeh, and which carries desolation into fields and gardens.

An important part is also assigned to apes in legends and parables. "When Noah was about to lay out his vineyard, Satan came up and asked him, 'Would you like to have me with you at the planting and the wine-making?' 'I am digging,' said Noah, evasively. What did Satan do? He brought up a lamb, a lion, a hog, and an ape, and killed them all in the vineyard till it was soaked with their blood. Thus it happens that man is soft and mild as a lamb after the first draughts; that he feels as brave and strong as a lion when he has drunken as much as agrees with him; then, when he has drunk more than enough, he becomes like a hog, disagreeable and boisterous; and, finally, when quite drunk, staggers and tumbles around, and makes faces, like a monkey." Perhaps the expression "to get as tipsy as a monkey" is derived from this. Synhedrin relates of the time of the confusion of tongues: "At the building of the tower of Babel men divided into three parties. One party said, 'We will go up to heaven and settle there'; the second party said, 'We will pray to our gods up there'; and the third party said, 'We will go up and make war.' The last were changed into apes and devils."

Seven vanities, says the "Kohelet," correspond with the seven phases of the life of man. When he comes into the world, everything kisses and embraces him; from two to three years old, he is like a pig, dirty, rooting everywhere, putting everything into his mouth; at ten years old he is jumping and capering about like a goat; at twenty, he is a horse, vain, enthusiastic, eager, looking around for a wife; when he takes a wife, he becomes an ass, bears burdens, and if he has children he is harassed like a dog to support them; and, when old, he becomes capricious and irritable, like an ape." A later writer, Salomo Ibn Verga, toward the end of the fifteenth century, describes the course of all things and beings as follows: "The coral forms the transition between the mineral and the vegetable kingdom, the sponge between the vegetable and the animal, and the ape is the intermediate

member between the animal and the man." Jalkut Reubeni remarks, "The ape veils itself before man as man does in the presence of the Shekinah." We recognize in this view the law brought into vogue by Leibnitz, and extended by Bonnet, of the continuous graded ascent of created beings. Finally, it is proper to state here that, according to the agadistic view, the primitive man as well as the ape, for the most part, lived only on vegetable food. "Flesh-eating was forbidden to Adam as well as to all his posterity till the time of Noah," say Lekachtob, Synhedrin, Jalkut Chadash, and Sefer Chassidim.

While the references to apes in the ancient writings of the Hebrews are generally of a matter-of-fact character, the stories and delineations by the ancient Arabians have, as a rule, a romantic stamp. The ape-men Nesnâs, which Maimonides believes to mean the Adne-hasadeh, play a conspicuous part in the Arabian travelers' stories, their romances, and their theology. I may state here that the ape is called in modern Arabic Nesnâs or Nasnas. A Mohammedan tradition runs: Ibn Abbas said: "Men (Nâs) have perished and the Nesnâs are left." He was asked, "What are Nesnâs?" and he replied, "Creatures which are like men and are still not men." Al-Gauharî defines the Nesnâs as "creatures that hop on one leg." The Nesnâs are very fully described by Al-Kazrwini as animals of a half-human figure which serve the people as food. They have half a body, half a head, a hand, and a leg, as if they were men split in two. This idea is, I believe, only the too literal and hyperbolical carrying out of the description of an ape as half a man. Wüstenfeld translates Nesnâs by "one-legged creature," and deduces from citations which he makes, that God changed men into Nesnâs as a punishment. The Koran, Surah ii, says: "You know what happened to those among you who profaned the Sabbath. We said to them, be apes and be excluded from human society, in order that they might be an example for the present and the future, and a warning to the pious." The Nesnâs were said to be Shemites, and descended from Shem's son Hasim; to speak Arabic, and to have Arabic personal names Ibn Ajjas, in his cosmography, describes the Nesnâs as creatures with one eye, one ear, and one leg. Maçudi gives a similar description and adds, that they rise out of the sea. The Nesnâs killed such men as they could catch.

According to another view, the Nesnâs were identical with Gog and Magog. Arabian historians speak of an invasion by a pygmy people called Nesnâs into Southern Arabia—a tradition which is referred by Fresnel to the irruption of the Roman legions. The question is raised in the casuistics of Mohammedan ritual, whether it is right to eat the flesh of the Nesnâs. As a rule such food is absolutely forbidden. Al Tabbarîi permits it, because aquatic animals are generally not forbidden. Wahrmund defines the Nesnâs as a "large ape, an orang-outang, a chimpanzee; a one-armed and one-legged satyr that hops fast." Muhîs-al-Muhîs of Albustâni says: "It is related in tradition

that a branch of the tribe of Ad rebelled against its prophets, and God changed them into Nesnâs, that is, into creatures with one hand and one leg, which hop like the birds and eat grass like the cattle. They say that this race has died out, and that such creatures of the kind as are found now are of a different creation (are not changed men). Common people call apes Nesnâs."

The ancient Egyptians did not represent the ape as a caricature of man, but idealized it and paid it religious honors, as they did to many other animals. A cynocephalus was kept and worshiped in the temple at Hermopolis, while a cercopithecus was honored at Thebes. Mummies of apes have been found in both of these cities. The ape also has its place in the hieroglyphics as the representative of the sound "en," and is called *ein* in Coptic. The god Anubis, who, at the judgment of the dead in Amenti (or the land of death), put the heart of the deceased in the balance of justice in order to report the result to Thoth, is figured with the head of a cynocephalus, or dog-faced baboon. Thoth himself generally appears associated with the attribute of the cynocephalus, the emblem of the dog-star. The temple of Queen Hatasu, at Der-el-bahri, is adorned with inscriptions relating to a grand expedition into the balsam-bearing land of Punt, the Egyptian Ophir, in which the offerings sent by the king of that country are described: "The transports were loaded to the full with the wonderful products of the land of Punt, and the various building-woods of the godly land, with heaps of balsams of incense, with green incense-trees, with ebony, with ivory, adorned with gold from the land of Amu, with liquorice-wood, chefit-wood, with frankincense, holy balsams, and eye-paints, with cynocephaluses and baboons and greyhounds, and with leopard-skins. Never was the like brought to any king of Egypt since the world has stood." According to Brugsch, the incense-trees stood on the decks of the vessels, and the apes, let loose, gamboled in the rigging, to the great delight of the sailors.

In the Indian Râmayana, where the animals are praised as allies of Rama, apes are depicted in groups, under the direction of a king who obeys the nods of Rama. They are not, however, introduced as idealized apes, changed men or incarnate demons, but as veritable apes with all their less pleasant peculiarities realistically portrayed. A favorite figure of the poem is Hanuman, the fool of the serious drama, around whom a fabulous atmosphere has already gathered. In him may be recognized the Hulman of the Hindoos, the Mandi of the Malabars, the sacred ape, *Semnopithecus entellus*. He is an Atlas, who bears mountains on his shoulders. A child of the wind and the air, he affords the most agreeable symbolism of the simian character. Like a rash child, he tried to go up to the sun, and still carries a remembrancer of his mishap in the deformity of his lower jaw, which is longer than the upper one. With his foolhardy, comic ways, he cheered and comforted Rama's beloved wife Sita, and helped deliver her from the

terrible Lanka, the city of the demon-king Râvana. In gratitude for this, Rama crowned him and embraced him in the sight of both hosts, of men and of gods.

In no land in the world has honor to apes struck as deep root as in India. Formerly temples were consecrated to them, and now, as Tavernier relates, asylums, special gardens, and hospitals are erected for them; and the Hulman is particularly regarded as sacred. Captain Johnson states that the natives of Baka leave a tithe of the harvest on the field for the Bhunder (*Macacus Rhesus*); and the penalty of killing this ape was death. The mild, human-like face of the orang-outang when quiet, and his deliberate, gentle, docile manner, contrasting with the nervous, convulsive restlessness of other monkeys, were well adapted to win for him the favor and reverence of the Indians; and this was apparently not affected by the knowledge of the ferocious appearance and manner he exhibits when enraged. The Javanese, remarking upon these features, say, "Monkeys could speak if they would, but they do not, because they are afraid that if they did they would be put to work." Indian princely families boast of their descent from apes, and bear the title of "tailed Rana." In the Indian metempsychosis the souls of the pious after death pass into the Hulman.

The apes of the New World received a similar treatment from its aborigines to that which was given to their relatives in the Old World. A remarkable correspondence is observable between the Aztec hieroglyphics for the days and the animal symbols which the Eastern Asiatics apply to the designation of the course of their year. The symbols in the Mongolian calendar are derived from animals, and among them four of the twelve coincide precisely with those of the Aztec calendar, and three are as nearly the same as the difference in the genera of the two hemispheres permits them to be. This will appear more plainly as an enumeration of the animal signs used by the Eastern Asiatics in describing their years. Among the Mongols, Mantchoo Tartars, Japanese, and Thibetans, they are the mouse, the ox, the leopard (or tiger), the hare, the crocodile (or dragon), the serpent, the horse, the sheep (or goat), the ape, the hen, the dog, and the hog. Among the Mexican names for the days we also find the hare, the serpent, the ape, and the dog; and instead of the leopard, crocodile, and hen, which were unknown in Mexico at the time of the conquest, the panther, lizard, and eagle. Thus, the Mexicans made the ape a symbol in the division of time and in chronological reckoning. Aztec traditions make mention, like those of the Hindoos, Thibetans, Persians, and Greeks, of four or five cataclysms, of cycles, after the fulfillment of each of which the world was destroyed, to be recreated anew. The belief in the recurrence at appointed times of these revolutions of nature through the operation of one or another of the elements was peculiar to many lands of the Eastern hemisphere, and has often been advanced as an argument in favor of the doctrine of a common origin.

The third age of the Mexicans, that of air, in which the Mayas conquered the giants of the former age, lasted 4,010 years, and ended in a hurricane by which all men except one pair were turned into apes. In the four ages of the Mexicans, which were called the ages of earth, fire, air, and water, we have to deal with a backward development, from giants to men, then to apes. This shows a curious agreement with the story of the Talmud, already referred to, that a part of the race at the confusion of tongues were turned into apes. It also curiously corresponds with the ancient Indian myth that made the ape a child of the wind and the air.

While the folk-lore on one side degrades the ape to a degenerate species of man, it on another side in compensation, as in Indian and among many negro tribes, derives the pedigree of distinguished families from apes, and consigns the souls of the honorable and pious to their bodily integuments. According to Brehm, the hair-tuft of the baboon serves the negroes of West Africa as the model for their coiffures. That lowly race also tries to exalt its similarity with the ape which the satirists of every zone make striking enough, and a humorous writer was not so far wrong when he described an ugly man as "a baboon, with hairs projecting from around his eyes." Not only bodily deformities and imperfections have been ascribed to apes, but moral transgressions also have been regarded and spoken of in the same view.

That the faculty of articulate speech is dependent on an upright position is suggested in the Hebrew book "Sohar Chadash," which says: "The animals can not look straight up to heaven, and therefore can not speak; and we learn of King Nebuchadnezzar that, when he was reduced to the condition of an animal, he could not help himself until he was able to rise and look up. Therefore he said to Daniel (Daniel iv, 34), 'I raised my eyes to heaven, and then my understanding returned to me.' If the animals, walking erect, could look up to the sky, they would be able to speak."

THE POISONS OF THE MANUFACTORY.

By HECTOR GEORGE.

THE cases of contamination of the air by means of insalubrious industrial operations may be divided into two groups: 1. Emanations (dusts or vapors) that act as poisons, and which, carried by the blood to all parts of the body, produce general and various disorders. 2. Dusts, of a simply irritating character, which act locally on the lungs, and produce in them disorders the intensity of which generally depends on the hardness of the particles.

We will begin with the poisonous dusts, taking first one of the most murderous classes—those of lead. Accidents due to lead are liable to occur among many classes of operatives who work with this substance either in a metallic state or in combination. Painters, miners, plumbers, type-founders, compositors, and glass-makers are peculiarly exposed to them.

The most obvious precaution to be taken against the admission of poisonous dusts with respired air is to arrest their passage by means of a protective veil or mask. An insurmountable obstacle has prevented the use of such a precaution. The workmen will not wear the screens, although effective and convenient ones enough have been made. Workers in white-lead ought also to wear special clothing for their work; but all that it has been possible to get them to do is to cover their ordinary clothing with overalls. This does not give sufficient security against the transportation of lead-dust by the clothes. Other important measures are those which have regard to cleanliness; here, again, we are opposed by an obstinate resistance. In a shop at Washington, near Newcastle, England, where the oxychloride of lead is prepared, the workmen quit because of an effort to introduce baths among them. They would not be shut up in a bath-room, although they would bathe very readily in the open air or in swimming-ponds.

A very essential precaution that workmen should always take is never to deposit or eat their food in the shop, or allow it to be in any way exposed to mixture with poisonous dusts.

Attention has been directed toward finding an antidote to lead-poisoning. M. Meisens, in 1843, recommended iodide of potassium, and it has been used with excellent effect; it cured declared diseases, as, for instance, paralysis; and permitted the continuance of work in lead without danger from colic. The Academy of Sciences awarded a prize for the discovery. Milk was recommended as a preventive of lead-poisoning by M. Didier-Jean, director of the glass-factory at St. Louis, near Sarreguemines, in 1867; but the workmen were not disposed to use it, and found a way to bring alcoholic liquors to the shop instead of milk.

General hygienic measures against this source of danger include the suppression of lead-dusts, that is the production of as little as possible of them, and the removal of them as soon as they are produced. Moistening, grinding, and mixing under water, closed apparatus for pulverizing, natural and artificial ventilation, substitution of machines for the hand, and mechanical packing—such are the improvements adopted by the factories at Brussels and Lille, with great advantage to the health of the workmen. Of two white-lead factories in Paris a few years ago, one was very unhealthy, furnishing from two hundred and fifty to two hundred and eighty patients a year to the hospitals; while the other, with the same number of men employed, was only slightly unhealthy, and furnished only two or three patients a year, or

a hundred times less. The difference depended on one condition only. The former factory made white-lead in powder or in cakes; the other prepared and sold it exclusively ground in oil. In the former process much dust, in the latter none, was disengaged.

Another step in progress may be gained, perhaps, by substituting inoffensive substances for the compounds of lead employed in industry. White-lead has already a rival in zinc-white, but it is objected to that substance that it has an inferior coloring power. To meet this objection, Mr. Griffith, of England, has prepared a white coloring substance based on sulphuret of zinc, which combines the coloring power of white-lead with the inoffensive qualities of the salts of zinc.

A pharmacist of Brest, M. Constantin, has received a prize from the French Academy of Sciences for the discovery of substitutes for the use of oxide of lead in the glazing of pottery: glazes based on lime for the uncolored, on oxide of manganese for colored, glazings.

A number of inoffensive colors deserve mention as substitutes for poisonous colors. Such substances as eosine, fluorescine, and other products derived from aniline, have been fortunately introduced in later years for painting children's toys.

Nothing need be said of copper. It is as inoffensive as lead is dangerous; and it appears, according to the researches of Dr. Burq, to confer upon workmen who handle it an almost absolute immunity against cholera.

Mercury is as dangerous as lead. It provokes salivation, destruction and loss of the teeth, tremblings, paralysis, and death. The workmen exposed to injury from it are miners employed in its extraction, gilders, looking-glass makers, and hatters. The personal hygiene is the same as for lead; but in securing its application we are still opposed by the carelessness and foolhardiness of the workmen.

The principal means relied upon for preservation against accidents from mercury are the employment of ammoniacal sprays in the shops, and of iodide of potassium, as for lead. Both remedies were recommended by M. Meisens after a long series of experiments, and have been used with excellent effect. The division of the labor in its most insalubrious phases and an energetic ventilation are excellent measures. Operations in mercury have been, moreover, much alleviated by the introduction of new processes. Gilding with mercury has been replaced by galvanoplasty; silvering of glass with mercury by a plating process which is performed at half the cost, and is without danger to health. Mercury is used by hatters in a secret process for impregnating the fur of the hare and rabbit, to make it felt, with a mixture of mercury, nitric acid, and water. Efforts have been made to find a substitute for quicksilver, and Dr. Hillairet proposed in 1872 to use molasses, but the experiment was not satisfactory.

Phosphorus is but little used among us except in the manufacture of matches. The troubles which it occasions are cough, headaches,

and disorders of the stomach. In the gravest cases, the inhaling of the vapors causes a more or less complete destruction of the bones of the jaws, in which they produce necrosis, especially in persons with decayed teeth. Such disorders have, however, become more rare. Besides finding a way to neutralize phosphoric vapors by essence of turpentine placed in a bottle, to be hung from the workman's neck, the vapors themselves have been suppressed by the adoption of processes in which all the dangerous parts of the operations are performed by machinery.

The General Match Company of France, which enjoys the monopoly of the manufacture in that country, has gradually introduced machinery, within the last ten years, by which the mixture of the phosphorus paste, the dipping of the matches, and the packing, are all done without exposing any one to the inhalation of the vapors.

Sulphide of carbon, which possesses the property of softening and inflating India-rubber, is much used in the manufacture of India-rubber foot-balls and balloons of various kinds. It occasions pains in the head and limbs; loss of appetite; paralysis of the sight, the hearing, and the limbs; cachexy, and death. It should not be handled except in closed vessels. M. Deschamps, of Belleville, invented a glass box, having two openings, for the passage of the hands and arms, to which were attached India-rubber sleeves, to be fastened at the wrist, and enable the hand to work within the apparatus without giving any outlet for the vapors; but the workmen laughed at the apparatus, called it a magic-lantern, and would not use it. There remains, then, no other resource than an active ventilation to carry off the poisonous vapors; and for that reason work in sulphide of carbon should be carried on only in large establishments, well ventilated, and should be excluded from small rooms.

Passing by the manufacture of chemicals, which is a special industry, involving many peculiar causes of insalubrity, and which deserves a full treatment by itself, we come to dusts that are simply irritating. They may be divided into two groups: those which are not soluble in the liquids of the body, and consequently accumulate in the lungs, and obstruct them; and those which, being soluble, have only a transient effect, and do not produce irremediable disorders. The first group includes the coal and the siliceous dusts; the second group all the others.

The accumulation of coal-dusts in the pulmonary vesicles produces, in coal-miners, workers in charcoal, and copper-founders, a malady designated by the name of *anthracosis*, which frequently ends in death. The lungs of victims of this disorder resemble a piece of sliced coal. In the personal hygiene against these elements, we mention the use of wadded masks, which has been followed by excellent effects in the mines of Belgium, where it has been possible to get them adopted. In general hygiene, Dr. Manouvriez (of Valenciennes),

some time ago recommended the projection of water, in the form of rain, to bring the dust to the ground. Fecula and talc have been used as inoffensive substitutes, in iron-founding, for charcoal, as the dusting between the mold and the melted metal.

Siliceous dusts are apt to arise especially in the making and re-dressing and re-cutting of millstones. They accumulate in the bronchiæ, which they scratch, and produce one of the most painful of coughs, with decline and loss of strength. Sometimes an eliminatory inflammation supervenes, with expectoration of masses of siliceous dust, particles of steel, and bits of bronchial membrane, and gives a temporary relief. But the disorders return, and the workmen have to leave the shops, to continue in a condition of marasmus an existence which is terminated by a premature death. The victims of this disease, called the St. Roch disease, are hardly ever able to endure more than eight or ten years in their occupation.

The dusts, moreover, which accumulate in the throat produce an incessant thirst, and lead the workmen to habits of intoxication. M. Mercier, of La Ferté-sous-Jouarre, a manufacturer of small mills, who himself works at the stones, has contrived a very thin and inexpensive silken veil, to which he has attached spectacles, for the protection of the eyes. He has used it with great success since 1870, but has not been able to induce more than twenty or twenty-five of his workmen to adopt it. The others laugh at it, and die of the dust against which they will not protect themselves.

Among the siliceous dusts should be included those arising in the manufacture of porcelain. At Charenton, St. Maurice, Montreuil near Paris, and Sarreguemines, the workers in porcelain die very frequently of pulmonary phthisis, hardly reaching more than the average age of forty-four years and a half, and rarely passing fifty years. The protecting veil ought to be used here also.

The dusts of gypsum, on the other hand, appear to be inoffensive, and even hygienic, according to Dr. Burq, who is almost tempted to attribute to them a salutary action in pulmonary phthisis. At any rate, the workmen recognize them as pleasant. They have only the single inconvenience, common to all dusts, of provoking thirst; and that thirst is not always quenched with pure water.

LITTRÉ, DUMAS, PASTEUR, AND TAINE.

THE names which we have placed at the head of this article are those of four of the most illustrious representatives of the intellect of France in the present age. M. Littré, whose recent death the Academy and the world of letters have to deplore, takes rank among

the greatest masters of language; M. Dumas still pursues his valuable researches in chemical science, and he combines with them an eloquence and elegance in literary composition not unworthy of his scientific renown; M. Pasteur has carried to their farthest limit the investigations of physiology, and has rendered incalculable services to mankind by tracing to their sources the germs of life, and of the diseases which affect life; M. Taine must be placed among the best French writers left to us since the extinction of the great historians, critics, and orators of the last generation. By a fortunate accident three of these eminent persons were called upon to take part on two memorable occasions beneath the dome devoted to the public sittings of the French Institute. That building, dedicated to letters, to science, to art, and to criticism, may be regarded as the last refuge and asylum of the genius and culture of France. It has resounded for two centuries to the voices of the great leaders of thought and eloquence of former generations; it still collects within its walls whatever is best and noblest in French society. This institution alone survives the great cataclysm which has swept away thrones, and churches, and orders, and constitutional government. The National Institute, and especially the oldest branch of it, the French Academy, still pursues its calm and dignified course, unshaken by despotism, by sedition, by popular tumults, by the violence of war, or by the scourge of revolution. Even during the siege of Paris we believe that its sittings were scarcely interrupted. Beneath the customary forms of academic compliments, which are in themselves idle ceremonies, it is not difficult to trace in its proceedings the language of earnest thought and warm feeling; and we shall have occasion to show that the great conflict of the age between faith and science, between the intellect and the senses, between spiritualism and materialism, between mind and matter, between the finite and the infinite, was the real subject of the discourses delivered on the occasions to which we now particularly refer.

But there was in this encounter a peculiar contrast. M. Littré, to whose memory the speech of M. Pasteur was devoted, was himself a Comtist; his philosophy was entirely negative; he denied everything which could not be brought within the evidence of the senses. These agnostic opinions were strenuously assailed by the eminent man of science whose duty it was to relate the touching history of his life. M. Taine, who had been elected to the Academy two years before in the place of M. de Loménie, disclaimed all adherence to Comtism, and spoke with very little respect of its founder, but his language was not less skeptical; it was a distant echo of the philosophy of the eighteenth century, which destroyed all beliefs and planted nothing in their place; it was an avowal of the supremacy of matter over mind, which is characteristic of all his own writings. To him M. Dumas replied with great force and point. The great chemist told him that all the researches of the present generation into the secrets of the material

creation indicated the existence of powers infinitely beyond it, and that the utmost advance in scientific knowledge only brought us to the verge of an incalculable horizon. The discourse in answer to M. Pasteur was delivered by M. Renan, but it proved to be a feeble and disjointed effort of French incredulity, without its wit. So that the cause of skepticism and negation was on these occasions upheld by the men of letters, inquirers into the origin of language and the phenomena of history, while the cause of belief in an infinite and supernatural power was defended by the men of science, whose lives have been devoted to the study of the natural world and to demonstration by the experience of the senses. The contrast was striking, and we think our readers may follow it with interest.

But, before we proceed to that part of our subject, we must pause to pay a tribute of respect, unhappily too long delayed, to the memory of the most remarkable of these eminent persons. There are other experimentalists, there are many historians, but M. Littré stands alone as the greatest of lexicographers, and the literary work accomplished by his almost unassisted labor was literally stupendous. We can use no other term. The character of the great "Dictionary of the French Language," to which he devoted thirty years of unremitting toil, is best described by its elaborate title-page. The mere material bulk of the work, which was published in four thick quarto volumes, is astonishing. The manuscript (without the supplement) covered 415,636 pages. The proof-sheets were 2,242. If the "Dictionary" had been set up in a single column of type, it would have extended over 37,325 metres, or about twenty-seven miles. The work was first projected in 1841, when M. Littré had already passed the fortieth year of his life; it was not till 1846 that the contract was signed with M. Hachette, whose liberal support was indispensable to the author. From that time forth the collection of authorities and materials, and the art of classification, which was the result of numerous experiments (some of them being abortive), occupied about thirteen years. Several persons were employed to read and extract, with a precise reference, passages from the whole body of the French classical writers from the sixteenth to the nineteenth century; to which M. Littré added, from his accurate knowledge of the old French chronicles and poets, a multitude of curious archaic examples from the thirteenth century downward. The arrangement of this enormous mass of materials seems to have been entirely done by M. Littré himself. The work of printing began in September, 1859, and was completed in July, 1872. Every proof passed under the eyes of four careful correctors, besides the printer's reader, and the final revision of the author. It took about two months to carry a sheet through the press. In the course of this vast operation 292 quarto pages of three columns each were added to the proofs. Twice the composition and execution of the work were interrupted by a revolution and a war; but, by assiduous efforts, M. Littré always kept

ahead of his compositors and correctors. We must leave him to relate in his own words how this was effected. The volume entitled "Glanures" contains a paper, written in the last hours of his life, entitled "Comment j'ai fait mon Dictionnaire," which tells the wonderful story of his literary existence: "My rule of life included the twenty-four hours of the day and night, so as to bestow the least possible amount of time on the current calls of existence. I contrived, by sacrificing every superfluous indulgence, to have the luxury of a dwelling in the country and another in town. My country abode was at Ménil-le-Roi, near Paris, a small old cottage with near an acre of productive garden, which *dapibus mensas onerabat inemptis*, as it did to the old man in the Georgics. There I was master of my time. I rose at eight; very late, you will say, for so busy a man. Wait an instant. While they put my bedroom in order, which was also my study, I went downstairs with some work in hand. It was thus, for example, that I composed the preface of the 'Dictionary.' I had learnd from Chancellor d'Aguesseau the value of unoccupied minutes. At nine I set to work to correct proofs until the hour of our mid-day meal. At one I resumed work, and wrote my papers for the 'Journal des Savants,' to which I was from 1855 a regular contributor. From three to six I went on with the 'Dictionary.' At six punctually we dined, which took about an hour. They say it is unwholesome to work directly after dinner, but I have never found it so. It is so much time won from the exigencies of the body. Starting again at seven in the evening, I stuck to the 'Dictionary.' My first stage took me to midnight, when my wife and daughter (who were my assistants) retired. I then worked on till three in the morning, by which time my daily task was usually completed. If it was not, I worked on later, and more than once, in the long days of summer, I have put out my lamp and continued to work by the light of the coming dawn. However, at three in the morning I generally laid down my pen, and put my papers in order for the following day—that day which had already begun. Habit and regularity had extinguished all excitement in my work. I fell asleep as easily as a man of leisure does; and woke at eight, as men of leisure do. But these vigils were not without their charm. A nightingale had built her nest in a little row of limes that crosses the garden, and she filled the silence of the night and of the country with her limpid and tuneful notes. O Virgil! how could you, who wrote the Georgics, describe as a mournful dirge, *miserabile carmen*, those glorious strains?"

We have never heard of another example of severe labor of the brain carried on systematically for seventeen or eighteen hours a day for so many years. But M. Littré, who was himself a great medical authority, is of opinion that it did him no harm. He was past forty when he began this work; he was fifty-nine when he began to print the Dictionary; he was seventy-two when he completed it; and he

lived to be near eighty. To these details we will only add that he abstained from every kind of luxury and indulgence, except a holiday of one month in the year, spent on the coast of Brittany. He lived on the smallest pittance on which life could be supported. Hachette allowed him a hundred pounds a year, but half of this sum went to his wife and daughter. He had previously saved forty thousand francs, but that was lost in the Revolution of 1848. The publisher's advances to the author amounted to no more than forty thousand francs, a sum which was eventually repaid out of the profits of the sale. But until the completion of the work the sale was small, and these thirty years of unexampled labor were at the time wholly unproductive. Happily, M. Littré's life was sufficiently prolonged for him to witness the triumphant success of his great undertaking. It brought affluence to his declining years; it placed him on the seats of the French Academy; it has given him fame far beyond his modest aspirations and his simple tastes. We have been informed that fifty thousand copies of the Dictionary have been sold; if this is the fact, it is without a parallel for a publication of this price and magnitude.

It is impossible for us within our present limits, and with the task we have now before us, to attempt a critical examination of this great work. Suffice it to say that the conception was as original as the execution is marvelous. The French language has been spoken and written for seven hundred years; like all languages, it has undergone vast transformations in that period; like all living languages, it is still undergoing a process of perpetual evolution. The Dictionary of the Academy is the standard of the accepted and existing language of France; it excludes archaisms, it condemns neologisms, it gives no references or derivations. M. Littré's design is far broader and more vast; it is based on the historical growth of the language, and it includes the history of every word in the language from its first occurrence, its etymology, and its various meanings, down to its modern use. The period of what is termed contemporary or classical French dates from Malherbe, a little more than two hundred years back; but, with few exceptions of recent date, every word has a tradition of centuries behind it. Thus, each article in M. Littré's Dictionary includes, first, the word; then its pronunciation; then the conjugation of the verbs, if irregular; then the definition of the various meanings of each word, illustrated by quotations from the best authors of the seventeenth, eighteenth, and nineteenth centuries, all textually referred to so that they can be found; and these meanings are scientifically arranged, always proceeding from the more simple and concrete to the more abstract and metaphorical. This classification of meanings is the most remarkable feature in the work, because it is executed with an extraordinary amount of philosophical discrimination. Take, for example, the word *Nature:* M. Littré dissects and unravels it into twenty-eight shades of meaning, and each of these is verified by ap-

propriate quotations and authorities. Such an article takes the reader into the depths of philosophical speculation; in tracing the history of a word he follows the history of thought. The verb *passer* runs to no less than sixty-six meanings, many of them amusing, proverbial, anecdotical. The word *faire* in French represents the two English verbs to *make* and to *do*. It consequently covers an immense field of action. M. Littré defines it as the word "qui dénote toute espèce d'opération qui donne être ou forme." He traces it through eighty-two shades of meaning, and the article he devotes to it is an essay of no less than eight quarto pages. Hence this Dictionary becomes attractive and even fascinating. Like Forcellini's Lexicon, which it most resembles, there is scarcely a passage or marked expression in the French classics which is not cited in it; but Forcellini and Ducange were dealing with dead or expiring languages; M. Littré had to force his way through the Babel of modern literature and society.

We now pass from the book to the man, whose life is scarcely less remarkable than the work to which he devoted it, and here we shall avail ourselves of the guidance of M. Pasteur in his discourse. Emile Littré was born in Paris, February 1, 1801. His father was an artilleryman of the first Republic, who had adopted with passion, both in politics and religion, the stern theories of the Revolution of 1791, and defended them in the patriotic army. He transmitted these opinions to his son, who inherited the same austerity of principles, tempered, however, by great natural benevolence. His mother was a woman of the same energetic stamp, though uneducated. Sainte-Beuve described her as "a Roman matron." The lad was educated at the Lycée Louis-le-Grand, his father having a small appointment in the office of inland revenue in Paris. The elder Littré learned Greek, and even began Sanskrit, to assist in the education of his son. On leaving college the young man acted for a time as secretary to M. Daru; but he desired to follow the medical profession, and had all but completed his hospital training, when his father died, leaving him too poor to take his degree and to enter upon practice. Accordingly, he never did practice medicine, except gratuitously among the poor of his village. Yet such was the medical reputation he acquired by his subsequent writings, that, as we have been informed, he was ultimately elected a member of the Medical Council of Paris. At this early stage of his life, in 1831, he was compelled to fall back on the humble occupation of a teacher of foreign languages and mathematics, and a translator of articles for the "National" newspaper, which made him acquainted with Armand Carrel. Meanwhile his mind, conscious of its strength, yet modest to excess, formed vast and varied projects, which he hesitated to execute. Such was the mastery he had already acquired over the sources of the French language, that he amused himself by translating a book of the "Iliad" into French verse of the thirteenth century. He also translated the elder Pliny, and in 1834 plunged into a greater

work, a translation and edition of the writings of Hippocrates, for which his medical studies had prepared him. Indeed, he continued to write on medical subjects, in which he always took the strongest interest. "Though I have studied medicine," he said, "without having made any practical use of it, I would not exchange for anything else this fraction of knowledge which I have acquired by persistent labor."

The use he did make of it was to watch over the health of his village, for to a rigorous austerity of life he united the utmost tenderness of heart, and, although he wandered far from all theological belief, his life was one constant example of self-denial, of consideration for others, and of what might be called the religion of duty. No monk ever lived on simpler fare or in a humbler abode. That cottage still remains in the state in which he left it, and over the table, as a visible symbol of reverence and toleration, hangs a picture of our Saviour. We have already related in his own language the extraordinary labor in which his days and nights were spent over the Dictionary. Yet his door was never closed against the visit of a friend; he continued to take part in the transactions of the branch of the Institute to which he belonged; and, yielding to the earnest solicitation of the widow of Auguste Comte, he consented to write, in addition to his other work, a biography of that personage.

Born and educated upon the devastated soil of the French Revolution, Littré had entered upon life without religious opinions; indeed, like the elder Mill, his father had deliberately withheld them from him. But at the age of forty he read the "System of Positive Philosophy" by Auguste Comte, and he thus described the impression he received from it: "This book subjugated me. A conflict arose in my mind between my old and my new opinions; the latter triumphed. I became a disciple of the Positive Philosophy, and I have remained so. For the last twenty years I have been an adept of this philosophy. The confidence I feel in it has never been shaken. Employed on very different subjects—history, language, physiology, medicine, erudition—I have constantly used it as a sort of tool which traces for me the features, the origin, and the conclusion of each question. It suffices for everything; it never deceives me; it always enlightens me." This is the best testimony ever borne to the value of M. Comte's philosophy; and it is borne by an eminent man, and that man a Frenchman. M. Comte has had but little honor in his own country; he was detested, despised, and to some extent persecuted in France while he was alive; and, with the exception of M. Littré, we have never heard that he has obtained any eminent disciple among his own countrymen.

From England, on the contrary, he received solid proofs of sympathy and interest, for he lived on an English annuity; and since his death his works have been carefully translated, and his opinions

adopted by some of the young and active minds of the present times. The French even deny him the merit of originality, and repudiate his system, probably because they know more of the man than we do. But we shall leave M. Pasteur to discuss it: "The fundamental principle of Auguste Comte is to set aside all metaphysical inquiry into first and final causes, to reduce all ideas and all theories to fact, and to restrict the character of certainty to experimental demonstration. His system includes a classification of the sciences, and a pretended law of history expressed by the assertion that the conceptions of the human mind pass successively through three states—the theological, the metaphysical, and the scientific or positive.

"M. Littré was full of praises of this system and of its author. In his eyes Auguste Comte was a man destined to hold a great place in posterity, and the positive philosophy was one of those products of a century or more which change the level of human thought. If he had been asked what he esteemed most in the laborious efforts of his life, Littré would doubtless have replied that it was his sincere and persevering apostolate of positivism. It is not uncommon to find the most learned of men deluded as to their own chief merits. I confess, therefore, that I have formed an estimate of the work of Auguste Comte differing widely from that of M. Littré. The causes of this divergence are the result of the very nature of the inquiries which occupied his life and of those which have exclusively occupied mine.

"The labors of M. Littré were directed to researches in history, language, and scientific and literary erudition. The subject of these studies lies entirely in facts belonging to the past, to which nothing can be added, from which nothing can be subtracted. The method of observation to be followed in them can seldom lead to strict demonstrations. Scientific experiment, on the contrary, admits no others.

"The experimentalist in the conquest of nature is continually opposed to facts not yet manifest, and which exist in the potential rudiments of natural laws. The unknown, within the limits of the possible, and not of the past, is his domain; and to explore it he employs that marvelous experimental method, of which it may be said with truth, not that it suffices for all things, but that it rarely deceives those who use it aright. The mistake of Auguste Comte and M. Littré was to confound this method with the simple method of observation. Unused to experimental philosophy, they use the word 'experience' in its ordinary signification, which is by no means its meaning in scientific language. The daily tasks of the man of science lead him to seek the idea of progress in an idea of invention. I find no invention in positivism. The mere gradation of the human intellect and the classification of the sciences have no claim to the title."

M. Littré found a certain repose of mind in the absolute denial by the positivists of all metaphysical truth. He was, in fact, what is now

called an agnostic. Without denying the existence of God and the immortality of the soul, he dismissed them from his thoughts, as subjects incapable of scientific demonstration. To this M. Pasteur replies:

"As for myself, holding that the words 'progress' and 'invention' are synonymous, I ask by what new philosophical or scientific discovery the soul of man can be torn from these lofty themes. They seem to me to be eternal, because the mystery that infolds the universe, from which they emanate, is itself eternal. . . .

"Positivism errs in more points than in its mistaken method. The thread of its argument, though apparently close enough, has in it a vast fault, which the sagacity of M. Littré might have detected. He frequently remarks, in speaking of positivism from the practical point of view, 'I call positivism all that is done by society to promote social organization on a scientific basis, which is the positive conception of the world.' I accept this definition if it be rigorously applied; but the great and manifest fault of the system is that it omits from the positive conception of the world the most important of positive ideas—that of the infinite.

"Beyond this starry firmament what is there? More skies and stars. And beyond these? The human mind, impelled by an irresistible power, will never cease to ask itself, what lies beyond? Time and space arrest it not. At the farthest point attained is a finite boundary, enlarged from what preceded it; no sooner is it reached than the implacable question returns, returns for ever in the curiosity of man. It is vain to speak of space, of time, of size unlimited. Those words pass the human understanding. But he who proclaims the existence of the infinite—and no man can escape from it—comprehends in that assertion more of the supernatural than there is in all the miracles of all religions; for the conception of the infinite has the twofold characters that it is irresistible and incomprehensible. We prostrate ourselves before the thought, which masters all the faculties of the understanding, and threatens the springs of intellectual life, like the sublime madness of Pascal. Yet this positive and primordial conception is gratuitously set aside by positivism, with all its consequences on the life of human society.

"The conception of the infinite in creation is everywhere irresistibly manifest. It places the supernatural in every human heart. The idea of God is a form of the idea of the infinite. As long as the mystery of the infinite weighs upon the mind of man, temples will be raised to it, be the object of adoration Brahma, Allah, Jehovah, or Jesus. Metaphysics are but the study of this commanding notion of the infinite. The same ideal conception is the faculty which, in presence of beauty, suggests the perfection of beauty. Science and the true passion for discovery are the effects of that intense desire to know, which is inspired by the mystery of the universe. And what is

the true source of human dignity, of liberty, of modern democracy, but the conception of an infinite power, before which all men are equal? 'There must be,' says M. Littré, 'some spiritual bond of humanity, without which society would lapse into isolated families or hordes, and be no real society at all.' This spiritual bond, which he placed in a sort of subordinate religion of humanity, can only consist in the lofty conception of the infinite, because the spiritual bond must be one with the mystery of the world."

The genius of M. Littré was essentially analytical. In that spirit he delighted to trace the uses of words and language to their roots and filaments; and he performed that task with consummate ability. But we discover in his writings no power of constructive reasoning. On the contrary, he was apt to mistake mere reveries and phantasms for the laws that govern society and the human mind. Thus in 1850 he announced "that peace for the next five-and-twenty years was foreseen by sociology, and, indeed, that peace was to last throughout the present period of transition, at the end of which a republican confederation would unite the west of Europe and put an end to armed conflicts." In 1878 he was obliged to confess that all his forecasts were mere delusions. In the interval four wars had broken out, and the great monarchies of Germany and Italy had consolidated their power at the expense of France. We have a profound respect for M. Littré as a philologist, but he certainly was not a politician nor a philosopher. That new-fangled term "sociology" covers a multitude of false speculations and puerile blunders.

M. Taine is not a disciple of Auguste Comte, and he professes no great respect for that positive philosopher. He is rather a follower of Condillac and the skeptics of the last century; and, as we have had occasion to point out in reviewing his works, he attributes, like the late Mr. Buckle, a sovereign power to matter over mind, and to external circumstances over the formation of individual and national character. We have not forgotten his caricature of English literature, which he ascribes to the carnivorous tastes of the Anglo-Saxon. He judges of the genius of a nation by its diet and its climate. On the occasion of his own reception at the Academy, in January, 1880, M. Taine delivered an *éloge* of his predecessor, M. de Loménie, which is really a masterpiece, unexceptionable in taste and style. No one has drawn a more faithful and graceful picture of the French society of the last generation, such as gathered round Madame Récamier at the Abbaye-aux-Bois. But these things have passed away. M. Dumas, the eminent chemist, in his reply to the new academician, touched on the vagaries of a more recent period, and did not leave M. Taine's materialist philosophy unnoticed.

He told him that "the fanatics of the naturalist school, upsetting language and placing the physical above the moral side of things, contend that, to judge of a man's work, you must trace his innermost life,

ascertain whether he was born on a calcareous or a granite soil, learn whether his ancestors and himself have drunk wine, cider, or beer, or eaten meat, fish, or vegetables—nay, you must penetrate the meanest details of his existence, and descend from the heights of criticism and from a scientific system to the gratification of a paltry curiosity."

This sarcasm was not ill-directed to its mark, but M. Dumas went on: "The physician and the naturalist may teach what is physical in man, that his nerves are sometimes instruments of pain, and that his body is but dust. That is their business. But philosophy and eloquence should cast their mantle of purple and gold over the baser aspects of life. It is their business to strengthen the heart of man and raise his soul to immortality. That is what you tell us has been done by Mr. Tennyson, the greatest poet of his time, if not of his country, whom some of his admirers place above Byron and not far below Shakespeare."

And the old man eloquent went on: "The philosophy of nature played a considerable part in the events of the last century. The schools of Greece thought they had penetrated to the elements of all things; the Roman poets, in turn, regarded themselves as the interpreters of creation; Diderot and his rivals boasted that they possessed the universe. But the discoveries of science in our own age prove that none but the ignorant can suppose that the whole book of wisdom has been revealed to us. The source of life and its essence are unknown to us. We have not seized that mysterious link which connects the body with the mind, and constitutes the unity of individual man. We have no right to treat man as an abstract being, to disdain his history, or to attribute to science an influence over the direction of the moral axis of the world, which its progress does not justify. We have, it is true, conquered the earth, measured the track of the planets, calculated the mechanism of the heavens, analyzed the stars, resolved the nebulæ, and followed the eccentric course of comets; but beyond those stars, whose light is centuries in reaching us, there are other orbs whose rays are lost in space; and farther, farther still, beyond all limits and all computation, are suns which we shall not behold, and innumerable worlds hidden from our eyes. After two thousand years of effort, if we reach the utmost extremity of the universe, which is but a point in the immensity of space, we are arrested on the threshold of the Infinite, of which we know nothing. 'The nature of man, his present and future existence, are mysteries impenetrable to the greatest genius, as well as to the rest of mankind,' said D'Alembert, at the height of his fame. 'What we know is but little,' said Laplace on his death-bed. Those were the last words of the illustrious rival of Newton. Let them also be mine."

The lofty idealism of these speakers repudiated alike the Comtism of M. Littré, the materialism of M. Taine, and the destructive criticism of M. Renan. It is no less opposed to that miscalled philosophy of

the senses which has found of late years so many able advocates among the men of science and the younger thinkers of England. The perceptions of the senses are undoubtedly the only guides we possess to a knowledge of the material world, and the inferences drawn from them by the faculties of the understanding are the legitimate conquests of physical science. But they entirely fail to explain the higher functions of the intellect, which are the domain of metaphysics; still less do we derive from the senses the moral laws of justice, of truth, of charity, of conscience; and least of all that conception of the supernatural and the infinite which it is the glory of man to trace in nature and in the emotions of the soul. Man alone, said Goethe, is a religious animal, and those who would degrade his nature to that of the brutes, begin by extinguishing in him the sense of religion.

These are, in other words, the sentiments expressed by M. Dumas and M. Pasteur. And who are they who hold this language? The one is a chemist, conversant with all the known properties of natural bodies and the marvelous combinations of the atomic theory which reduces them all to a few primitive elements. The other is a physiologist who has refuted the theory of spontaneous generation, and established on a solid basis that life alone can impart life. They have both traveled as far on the road of natural science as it will take them; they have even enlarged the bounds of physical knowledge. But, arrived at that term of man's labor, they acknowledge that an infinite horizon of thought, of action, of forces, and of power lies beyond the scope of sensuous observation. He studies Nature with a careless eye and a benighted mind who does not perceive that the supernatural lies in it and above it. For when all is said that science can teach, and all is done that skill can achieve to cultivate the earth and bring forth its fruits, one gift remains without which everything else were vain—that gift which the Supreme Creator has reserved absolutely to himself—that gift which man and every living creature can take away, but can never restore—that gift without which this earth would be no more than the cinder of a planet—the mystery and the miracle of LIFE. Life is everywhere; without life nothing would exist at all: matter would be the *caput mortuum* of the universe. With the diffusion of life creation begins; and of that act all but a supernatural power is incapable. The seed of cummin you commit to the earth includes it; the single grain of wheat shoots up, not only to reproduce itself, but to multiply its ears a hundred-fold and in successive generations, millions upon millions of times, and to nourish a world; the acorn carries in its little cup a thousand years of vitality; the midge and the butterfly that sport for a day upon the rushes and the blossoms enjoy it; the laborious earth-worm that builds up the fertile soil of our fields and gardens has it; it ascends through all the scale of existence until it arrives at Man, a being capable of conceiving Infinite Power and hopes

of an everlasting future. Yet who shall say what Life is? What is the value of a system of philosophy which denies or discards the only rational solution of the very first problem and condition of our own existence?—*Edinburgh Review.*

THE CHINESE: THEIR MANNERS AND CUSTOMS.

THE manners and customs of the Chinese—an extensive subject, and our canvas a narrow one.

But where to begin?—Domestic life, religion, war, courts of justice, schools, literature, are all alike almost unknown. Be chance our guide. A paper is lying open on our table: it is the "Times." Let us follow the order of its articles and commence at once with the article of births, marriages, and deaths.

Births will afford us but little subject for remark. Let us, however, suppose that the solemn bath appointed for the third day is over, which would seem to be almost a Chinese baptism, and the mother to be convalescent. If the offspring be a girl, there will probably be no rejoicing, but, if a boy, the mother will go in state to the temple frequented by her family and offer thanks to Tien How, the queen of heaven. The only time it was our fortune while in China to see a native lady of any standing was on such an occasion. A wife of Howqua, the son of the celebrated Hong merchant, had gone to the Temple of Honam to return thanks for the birth of a son. The shrine in the temple which she was visiting had been founded by the elder Howqua in honor of his ancestors: it was a lofty hall with roof open to the beams, closed in the rear and at the sides, but in front opening with richly carved doors on a raised terrace surrounded by a stone balustrade and overlooking a square, turfed inclosure containing two or three fine specimens of the Chinese banyan, or *Ficus religiosa*, and a pond of water covered with the broad green leaves and rose-tipped flowers of the lotus, the sacred plant of Buddha, who is often represented as seated on its open flower. Crossing this pond and skirting it were a bridge and gallery of massive stone carving, corresponding with the balustrades and communicating with the terrace. On the opposite side of the gallery was seen the rear of another shrine, colored of a deep vermilion like the one in front, with its high arched roof sweeping down like the curved outline of a Tartar tent (from which the Chinese style of architecture is supposed to be borrowed), and adorned with dragons, birds, and dolphins in glazed pottery of the brightest colors. Down either side stretched a line of gloomy cloisters communicating with the rest of the building. At one end of the terrace were two or three small tables arranged with viands placed

upon them and surrounded by a considerable party of Chinese, among whom we noticed several females standing, evidently in attendance upon some lady, as in China the servants are almost invariably of the other sex. Knowing the scruples of the Chinese against admitting foreigners into the presence of the female members of their families, we turned back, and were on the point of leaving that part of the temple, no little disappointed at being unable to see the whole of the building, when two members of the group, one of whom was a son of Howqua, came forward and requested us to continue our examination, if we wished. We did so. The shrine at which the ceremony was going on had been decked with flowers, while on the long, counter-like altar in front of the figure of the goddess, between the jars of porcelain and bronze half filled with sandal-wood ashes in which sticks of incense were burning, and upon two square pedestals in front of the altar, were piled up pyramids of fruits and sweetmeats. On either side of these pedestals were two of smaller size, on each of which was placed a book apparently of religious service, and by its side a small wand and a hollow, red, kidney-shaped gourd, which when struck gave a hollow and not unmusical sound, each blow upon it marking the repetition of a prayer. These, as it were, formed the lecterns of the officiating priests; and between them, facing the central vase on the high altar, were placed a cushion and a mat on which the fair devotee might kneel and perform the *kotou*, or ceremony of kneeling and touching the ground with the head at certain periods during the service. At either side of the central door of the shrine stood a large bronze vase heaped with silvered paper formed into boxes about the size and shape of steel-pen boxes, and emblematical of bars of Sycee silver, which is burned at the conclusion of the ceremony as an offering to the queen of heaven.

On passing out of the shrine, still accompanied by the two Chinese who had joined us, we passed near the banqueting party, when the lady rose, supported by two of her servants, and, crossing her hands, saluted us in the Chinese fashion. Of her beauty I can say nothing; neither my companion nor myself could remember anything save a face painted *à la Chinoise*, and hair tied up in the usual tea-pot form, dressed with magnificent pearls, jade ornaments, and natural flowers. The golden lilies, as the inhabitants of the Flowery Kingdom call the crippled feet of the higher classes of their women, and the splendidly embroidered robes, attracted our attention far more than the eyes and features, which doubtless ought to have been our only consideration.

It is after this festival, not always, of course, celebrated with the magnificence we have described, that the relatives of the child present it either with plate, or bangles of silver or gold, on which are inscribed the characters signifying long life, honor, and felicity. It is also at this period that it receives its "milk-name," or the pet name by

which it is known in its family, the name by which it is known to others being only given to it at the completion of its fourth year, when its education is supposed to commence.

We have all heard the Chinese charged with infanticide. We believe that crime to be less prevalent with them than it is with us. If children are ever exposed, as has been seen on a way-side altar near Honam, we believe that bitter want and a hope that charity would provide for the child better than the mother could have been the moving causes. As a general rule, self-interest acts as the strongest bar to this vice. That the life of the male children should be preserved is most important, as the Chinese law will compel the sons to maintain their parents, and, in the event of all the sons dying, no one would be able to offer that worship at the tomb of the father and mother on which their happiness in another state is supposed to depend. With the girls preservation is almost as important, and they are a marketable commodity, either as wives or as servants. Indeed, it is no very rare thing to see a basketful of babies sent down from Canton to Hong-Kong for sale at prices ranging from two to five dollars. These are all girls; and the purchase of one or more of them is generally the first investment that a Chinese Aspasia makes of her earnings, a speculation sure ultimately to pay a very large interest on the money sunk.

In denying the existence of infanticide it is necessary to make one exception. This is among the Tan-kia, or boat-population. These are a race of people of different descent and different religion from the Chinese, governed by their own magistrates, and so looked down upon by the other classes that no child of a boat-woman can compete in the literary examinations, or, whatever his ability may be, become an aspirant for office. This class is excessively superstitious, and we have heard it stated by missionaries that, when a child belonging to people of this class suffers from any lingering malady, and recovery becomes hopeless, they will put it to death with circumstances of great cruelty, believing it to be not their child but a changeling, and fancying that a demon has taken the place of their offspring for the purpose of entailing on them expense and trouble for which they could never get any return.

The next article we come to is *marriage:* hedged in with formalities in all countries, but in none more so than in China. As we have just been speaking of the Tan-kia people, let us take Dr. Yvan's account of one of their marriages, and have done with them:

"In harvest-time," says the doctor, "any man of their class who wishes to marry goes into the next field and gathers a little sheaf of rice, which he fastens to one of his oars. Then, when he is in presence of the Tan-kia girl of his choice, he puts his oar into the water, and goes several times round the boat belonging to the object of his affections. The next day, if the latter accept his homage, she, in her turn, fastens a bunch of flowers to her oar, and comes rowing about near her betrothed."

The relatives on both sides assemble on board the girl's boat; there is a general feast, a great firing of fire-crackers, beating of tom-toms and burning of joss-paper to frighten off evil spirits, the cup of union is drunk together, the bride is taken to her new floating home in a closed sedan of red and gold, and the ceremony is at an end. The rice in the above case is emblematic of the support promised by the man, the flowers of the happiness offered by the woman.

Among the pure Chinese, and especially among the higher classes, the affair is a much longer and more serious one. From the almost Turkish strictness with which females are secluded, it is comparatively rare that a couple see each other previous to betrothal, and still more so that there should be any acquaintance between them. This has given rise to the necessary employment of a character equivalent to the *bazvalan* or marriage-broker of ancient Brittany, to Mr. Foy's Parisian Matrimonial Agency Office, or the daily marriage advertisements of our own papers. If your wish is for marriage in the abstract, the broker will find you a fitting partner first, and negotiate the transfer after. If you are less purely philosophical, and wish to consult your own tastes as well as the interests and increase of the nation, you are only to name the party, and the broker becomes your accredited embassador. There is, however, one preliminary point to be ascertained. Has your intended the same surname as yourself? If so, it is a fatal difficulty, as the laws of China would not permit the marriage. If, however, she is Chun and you are Le, or she is Kwan or Yu, and you rejoice in any other patronymic monosyllable, the next step is for the broker to obtain from each a tablet containing the name, age, date and hour of birth, etc. These are then taken to a diviner and compared, to see if the union promises happiness; if the answer is favorable (and crossing the palm with silver is found to be as effectual with fortune-tellers in China as it is elsewhere), and the gates are equal, that is, if the station and wealth of the two families are similar, the proposal is made in due form. The wedding-presents are then sent, and, if accepted, the young couple is considered as legally betrothed. A lucky day must next be fixed for the wedding, and here our friend the diviner is again called upon. Previous to the great day the bridegroom gets a new hat and takes a new name, while the lady, whose hair has hitherto hung down to her heels in a single heavy plait, at the same time becomes initiated into the style of hair-dressing prevalent among Chinese married ladies, which consists in twisting the hair into the form of an exaggerated tea-pot, and supporting it in that shape with a narrow plate of gold or jade over the forehead, and a whole system of bodkins behind it. On the wedding morning, presents and congratulations are sent to the bridegroom, and among the rest a pair of geese; not sent, as we might imagine, by some wicked wag or irreclaimable bachelor as a personal reflection on the intellectual state of his friend, but as an emblem of domestic

unity and affection. The ladies, too, in China as well as elsewhere, indulge in a little fashionable crying on the occasion, and so the relatives of the bride spend the morning with her, weeping over her impending departure, or, more probably, their own spinsterhood. They do not, however, forget to bring some contributions for her trousseau. In the evening comes the bridegroom with a whole army of his friends, a procession of lanterns, a long red cloth or silk tapestry embroidered with a figure of the dragon, borne on a pole between two men, and a large red sedan covered with carving and gilding, and perfectly close. In this the bride is packed up securely out of sight, and the whole procession, preceded by a band of music and the dragon and closing with the bride's bandboxes, starts for home. On arrival she is lifted over the threshold, on which a pan of charcoal is burning, probably in order to prevent her bringing any evil influence in with her. She then performs the *kotou* to her husband's father and mother, worships the ancestral tablets of her new family, and offers prepared betel-nut to the assembled guests. Up to this time she has been veiled, but she now retires to her chamber, where she is unveiled by her husband; she then returns, again performs obeisance to the assembled guests, and partakes of food in company with her husband; at this meal two cups of wine, one sweetened, the other with bitter herbs infused in it, are drunk together by the newly married pair, to symbolize that henceforth they must share together life's sweets and bitters. The bride then retires, escorted by the matrons present, some one of whom recites a charm over her, and arranges the marriage-couch. The next morning the gods of the household and the hearth are worshiped, and the six following days are devoted to formal receptions at home of different members of the two families or equally formal visits paid to the family of the bride. During the whole of this period she still travels in her red-and-gold sedan, and is still escorted by her band of music and dragon.

Such are the ceremonies with which the chief or number one wife is espoused, and of this rank there can be but one. Taste and depth of pocket give the only limit to the number of subsidiary wives that may be taken. These are married with far less ceremony than the first, are often from a different class of society, being literally purchased, and act to a certain extent as servants or attendants to the chief wife. They are, however, legal wives, with recognized rights and position; their children are legitimate, and inherit in equal shares with those of the first wife. Indeed, this last is considered as the mother of the whole family, and the children are bound to display toward her more reverence than even toward their natural parent.

But even in the Flowery Land, people sometimes find that the bitter predominates over the sweet in the cups of alliance, and that the geese borne in the marriage procession are emblematical of something else besides domestic affection. In a word, they occasionally want to

be unmarried. And really they have made a very fair provision for enabling themselves to loose the knot. Not only do they admit such grounds of divorce as would satisfy Sir Cresswell Cresswell, but they add to them inveterate infirmity, disrespect to the husband's parents, thieving, and, most comprehensive class of all, ill-temper and talkativeness. However, if the husband has acquired property since his marriage, if the wife has no parental home to which she may return, or if she has mourned for her husband's parents, divorce can not take place. It is one of the many exemplifications of the Chinese maxim that the laws should be severe, but tempered with mercy in their administration.

There is, however, another dissolution of marriage over which law has no power—that which is effected by the hand of death. The widow is not forbidden to remarry, but by so doing she loses many privileges, and her conduct is considered somewhat light and irregular. Nature, however, will occasionally speak louder than fashion, and it may be worth while to repeat the tale told by Chwângtsze, the great Chinese philosopher.

A Chinaman died soon after his marriage with a young and lovely woman. As he was dying, the wife was loud in her protestations of grief, and her determination not to marry again. The husband was not unreasonable; he only asked that if she did take another spouse she would wait till the earth upon his grave was dry. He died and was buried; and many a young and handsome bachelor of the province of Shantung was present at his funeral. She listened to no suitor, for woman's heart is tender, and she could not so soon forget the lost one. Daily she stole to his grave. She wept, but no tear fell upon the soil, she took good care of that. At last, after a few days, Chwângtsze happened to pass, and saw her fanning, not herself, but the damp earth. He asked the reason. She told him of her husband's last request, and begged him to assist her. She offered him a fan to assist her, and there they sat to fan away the moisture: the grave was *so* long a-drying!

Poor Chwang! He was not much more lucky himself. He did not take the widow, but neither did he take warning. The geese were carried for him, and were *very* typical of *himself*. He had nothing to do for it at last but to quit political life, in which he had gained some distinction, and turn philosopher. But we will have "no more scandal about Queen Elizabeth," lest rosy English cheeks should take the part of China's golden lilies, as we have known widows at home almost in as great a hurry as those of the province of Shantung.

But even to the poor Chinaman death must come at last, even though there is no paper in Canton, so far as we know, to furnish a notice of his life and death, and to publish an abstract of his will, as is the case in more civilized countries. To him it comes armed with few terrors, so long as he leaves behind him male offspring to make

the prescribed offerings at his tomb. We have stood by many a Chinese death-bed, and though the dying man might "prattle o' green fields," and fancy himself once more surrounded by his friends amid the peach-groves of Hiang Shan, while his frail body was tossing on the stormy waves of the Indian Ocean, yet there was no sign of dread with regard to the future that awaited him. But there, far out at sea, there was no opportunity for witnessing the ritual of death But one brief hour after the eye has glazed, and the jaw has fallen, the canvas-shrouded and shotted corpse takes its last plunge into the blue ocean depths, without a prayer, without a rite save the few *cash* sprinkled by his remaining comrades over his watery tomb.

On shore a very different spectacle is presented. As the last hour draws near, the relatives wander round the house with cries, the gong is incessantly beaten, and packet after packet of fire-crackers gives out its short, sharp series of detonations, sounding like irregular platoon-firing, to frighten away the evil spirits supposed to be watching round the house to seize the departing soul; while, within, upon the filming eye the smoke of the ever-burning incense mingles with death's gray shadow. The eye has closed, the spirit has departed, and now every door and window is flung wide open, and the "keen" rises wildly to recall the wandering guest to its deserted tenement. And now the death is announced to all the relatives; the door is hung with white drapery, and down each lintel hangs a scroll of white, on which appear funereal inscriptions in blue. Large blue-and-white lanterns are hung on either side of the entrance, and probably a bamboo portico, thatched with matting, is erected to preserve lanterns, inscriptions, and garlands from the weather. Should it be a parent who has passed away, two figures of the stork, the emblem of longevity, appear amid the decorations. The relatives of the deceased, robed in white, and with white cloths bound about their heads, now go in procession to the nearest spring or river; before them is supported the nearest heir of the deceased, wearing a white veil, showing signs of the deepest affliction, and bearing in his hand a bowl in which are two copper coins, whose united value is about half a farthing. This company, uttering the most dismal howls, and having in its train musicians whose performances are scarcely less doleful, has gone to purchase water to wash the dead. This ceremony having been performed, the body is dressed as in life, and placed in its coffin, which has previously been half-filled with quicklime. The lid is then put on, and cemented down, the whole of it being afterward highly polished, and the name of the deceased inscribed upon it.

The coffin, it may be as well to remark, is not a slight shell like those in use among us, but is either a hollowed tree or made in the form of one—the sides being rounded, and five or six inches in thickness. They are formed of very hard and costly woods, reaching occasionally the price of five hundred pounds. A handsome coffin is

considered as acceptable a birthday present as a son can offer to his father, and coffins so given are often preserved unused for years.

The coffin having been closed, it is covered with a white cloth, and watched for twenty-one days. During this period a small red board, with the names of the deceased in raised gilt letters, standing on a pedestal, and having an opening in the back, stands near the corpse, and is the object of a species of worship. It is called the ancestral tablet, and the hole in the back of it is intended to give admission to the spirit which is supposed to inhabit it. Should the family possess no available burial-ground, a diviner is consulted to choose some lucky spot for a tomb, which must be outside a town, and generally at some distance from it, a favorite spot being on the slope of a hill overlooking water. The tombs are formed in the shape of a horseshoe, consisting of a flat platform, under which the body is laid, surrounded by a raised wall, in the center of which a stone is placed, bearing a copy of the inscription on the ancestral tablet. Of course, the degree of ornament about the tomb depends in great measure on the rank and wealth of the deceased.

It by no means follows, however, that the body is buried at the close of the twenty-one days. The necessity to choose a lucky site, or the wish to transport the coffin to some distant burial-ground, may cause delays; and cases have been known where the delay has arisen from less justifiable motives. The Chinese law will not enforce the payment of rent so long as the body of the tenant's grandfather remains unburied in the house; nor is a man's property distributed till his funeral rites are completed. Hence the necessity which sometimes arises of taking legal steps to compel the burial.

Under different circumstances, the body of the great viceroy Yeh lay for months unburied. Let us give a description of his coffin, as it was not many months ago. A few rods outside the east gate of Canton, back from the street, stands an unpretending Taonist temple. A plain, unornamented gate opens the way into a long, narrow inclosure, which leads up to the shrine. The grounds seem deserted, save that one old Chinaman stands by the inner gate. He is no doorkeeper, but a street beggar. Yeh, the viceroy of Canton, has no doorkeepers now.

We pass beneath another archway, and up a passage hung with white, till we reach the apartment of the dead. Here, at length, we meet a few attendants, and a Taonist priest officiates as our guide. He leads us into a small hall about twenty-five feet by twenty, hung with blue cloth, on which funereal inscriptions are embroidered in white silk. An altar stands in the middle of the room, on which are placed some dozen bowls of cooked vegetables and piles of artificial fruit, and sticks of burning incense. Behind the altar is a tablet of white silk on which are embroidered the names and titles of the late viceroy, and behind this, again, a curtain hangs from the roof to the

ground. We raise and pass the curtain, and before us stands the coffin.

It is a plain box, but of great size, being twelve feet in length and four in thickness, each side consisting of a single slab of hard and costly wood brought from the province of Sze Chuen, far in the interior. Its cost was over fifteen hundred dollars. The man who for years ruled with a rod of iron—before whose mandate one hundred thousand heads fell in the execution-ground of Canton, whose diplomatic skill baffled for years the ministers of European powers, who, when his city was little better than a ruin and a desert, could not fight, and would not yield lest he should betray the prestige of the inviolability of Canton, after all his power, skill, and obstinacy—lies unhonored and almost unattended without the walls of the city which he could rule but could not save.

But we must hasten to a close. The grave having been fixed upon and the day for interment appointed, an altar is prepared in the room in which the body lies, and upon it are piled fruits and cakes, while in front of it we see a roast pig and a goat, the two latter being often made in lacquer-ware, and hired for the occasion. At the door are placed musicians, and from time to time large masses of silvered paper are burned at the entrance of the room. The body is then escorted to the tomb, all the mourners dressed in white, and the offerings, pig, goat, and all, form part of the pageant. But the principal object is the ancestral tablet, borne in a red shrine, and often accompanied by the figures of the household gods. On reaching the grave some religious ceremonies are performed, large quantities of silvered and gilt paper, and imitations of clothes, ships, etc., are burned, this being the readiest way of supplying the wants of the deceased, and forwarding his luggage to the spirit-land. The provisions furnish forth a feast, the coffin is interred, and the ancestral tablet borne back to the ancestral hall, where we will leave it, until the return of the period for the worship of the dead leads us back to the now closing grave.—*Temple Bar.*

SKETCH OF THOMAS SAY.

By J. S. KINGSLEY.

THOMAS SAY, the father of American zoölogy, was born in Philadelphia, July 27, 1787. Of his youth we know comparatively nothing. At an early age his parents, who were Quakers, placed him in a boarding-school under the control of the Friends, but Say did not take kindly to the instruction there provided, and acquired nothing but a most intense dislike for his teachers and for all ordinary branches of study. We are justified in ascribing this antipathy on his part to

the incompetency of the instructors, for in after-years Say showed an ability and a desire to learn which only the most repressing circumstances could have checked in his youth. Dr. Benjamin Say, the father, was an apothecary, in moderate circumstances; and young Say, after leaving school, was placed for a time behind the counter of his father's shop. After he had acquired some knowledge of the drug business, his father established him in trade with John Speakman, who was a member of the Academy of Natural Sciences of Philadelphia. Through Speakman, Say was induced to join the society, and with this act he began a life of science which has left its impress on every branch of natural history.

Say is considered as one of the founders of the Philadelphia Academy, but this is not exactly so. The academy was founded January 12, 1812, while Say was not elected to membership until April of that year, and his first attendance at the meetings was on April 16, 1812. What was his surprise, on entering the temple of science, to find the whole collection of specimens consisting of "some half a dozen common insects, a few madrepores and shells, a dried toad-fish, and a stuffed monkey!—a display of objects of science calculated rather to excite merriment than to procure respect." In fact, the academy was a social organization. This is shown by its first constitution, the preamble of which runs somewhat as follows (we quote from memory): "Whereas, we believe that we can obtain the same amount of pleasure and enjoyment, and at a less expense, around a common fireside and a common candle, than we can, each at his own fire and beside his own light," etc. With the advent of Say to membership this was soon changed, and the academy took its place among the scientific bodies of the world, a place which it has since occupied, though at times it has seemed to many of its friends that it was not doing the work which it ought. At present, under the able presidency of Dr. Leidy, it promises to take a higher stand than it ever has in the past.

Long before joining the academy, Say had acquired a familiarity with the forms of beetles and butterflies, but without reducing his knowledge to systematic order. Now, on joining a scientific society, he began those investigations on the American fauna which only ceased with his death. His partner, Speakman, fully sympathized with his passion for nature, and willingly did the labor of both in the shop, so that Say might devote all his time and energies to his favorite studies. Soon, however, this comfortable arrangement was brought to an end; the firm of Speakman and Say, in an evil hour, indorsed for friends, and, as a not unnatural result, came to grief. Say then took up his residence in the rooms of the society, making his bed on the floor, cooking his own food, and living at an expense at times not exceeding seventy-five cents a week. Had he, like Thoreau, given an account of his life at this time, it would have been an interesting chapter.

In 1816 he projected a work on American entomology, and in the next year six plates and the accompanying text were printed, but, from a lack of proper pecuniary support, the project for the time fell through, and the work was not properly published until a later date. In 1817 William Maclure and several other men of influence and property joined the academy, and through their efforts the "Journal of the Academy of Natural Sciences of Philadelphia" was started, and Say began his long list of contributions to knowledge. No complete list of his papers has been published, but the number aggregates nearly one hundred.

In 1818 Say, in company with William Maclure, George Ord, and Titian R. Peale, visited Georgia and Florida on a collecting expedition, and in the next year Say received an appointment as naturalist on Long's expedition to the Rocky Mountains, with Peale as an assistant. Peale is now the only survivor of either expedition, and at a ripe old age continues his scientific labors. The writer has heard many an anecdote of these trips from him. Long's expedition left Pittsburg, Pennsylvania, in May, on a steamboat built for the purpose, and proceeded as far as Council Bluffs, Iowa, where they spent the winter. During the next year they went to the Rocky Mountains, and, returning by another route, broke up at Cape Girardeau, Missouri, in November. Say appears to have been unfortunate on this expedition. At one time he was in charge of a party of five, making a trip on foot, when the pack-horse broke loose, and they lost both horse and baggage. Later, in charge of another party, he fell in with a number of Kansas Indians, and again lost horses, baggage, and camp equipments. The narrative of Long's expedition was published in two octavo volumes and folio atlas (Philadelphia, 1823), and some of Say's descriptions of the animals and "animal remains found in a concrete state" were given in foot-notes scattered through both volumes.

After the disruption of the party, Say, in company with one or two others, went to New Orleans, and soon returned to Philadelphia. His next trip was with Long's second expedition, which explored the sources of the Mississippi River; but, with the exception of this and one or two minor expeditions, the next few years were spent in Philadelphia.

In 1825 Say left his native city, never to return. William Maclure, who was a man of wealth and refinement, but considerably eccentric withal, had an idea that the "community system" was the true way of living, and, unlike some other dreamers, he proceeded to put his plans into execution. A large tract of land was purchased at New Harmony, Indiana, and there the community was started. Numbers of people, among them Thomas Say, Gerard Troost, and C. A. Lesueur, influenced by the arguments of the projectors and the glowing accounts of the happy life to be led by a people possessing all things in common and working for a common good, removed themselves and theirs to

this modern Utopia. The community, however, did not prosper; internal dissensions, as might have been expected, sprang up, and the aid of the courts was invoked. Maclure, utterly disgusted, went to Mexico, and left Say at New Harmony as his agent, to attend to the settling of the affairs of the community. This was not an agreeable task, but, without other means of support, Say was obliged to accept, and continued in this position until his death. This stay at New Harmony was not a period of scientific idleness on the part of Say, as the numerous contributions which proceeded from his pen attest.

At his death his collections and library came into the possession of the Philadelphia Academy. The insects were submitted to another entomologist for arrangement, but through an unpardonable neglect were allowed to go to complete ruin before their return to the academy, and the types of hundreds of species were thus irrevocably lost. The remainder of his types are principally the property of the Philadelphia Academy, where they are as religiously preserved with his own labels as are those of Linné and Fabricius in London, or of Herbst in Berlin. The number of new species which Say described has probably never been exceeded, except in the cases of those two exceedingly careless workers, John Edward Gray and Francis Walker, of the British Museum. There is this in Say's favor, which can not be said of the two just mentioned, that his descriptions are, almost without exception, easily recognized, and almost every form which he described is now well known. Working as he did without books, and without that traditional knowledge which obtains among the Continental workers, it was unavoidable that he should redescribe forms which were known before; but, owing to the clear insight he possessed, and the discrimination he exercised in selecting the important features of the form before him, his work has never caused that confusion in synonymy which many in much more favorable circumstances have produced.

Say's work was almost wholly the scientific description of the forms which came under his eye, and there is scarcely anything in his writings concerning the habits of animals, or which appeals in the slightest to the popular taste, and his language frequently is not of chaste and classic character. An extract from his "American Entomology" will illustrate this: "During the progress of Major Long's expedition up the Missouri, that enterprising and excellent officer intrusted me with the direction of a small party of thirteen persons, destined to explore the country on the south side of that extended river. After encountering many obstacles and privations, which it is unnecessary to enumerate, the party arrived at the village of the Konza Indians, hungry, fatigued, and out of health. Commiserating our situation, these sons of nature, although suffering under the injustice of white people, received us with their characteristic hospitality, and ameliorated our condition by the luxuries of repletion and repose.

Whilst sitting in the large earth-covered dwelling of the principal chief, in presence of several hundred of his people, assembled to view the arms, equipments, and appearance of our party, I enjoyed the additional gratification to see an individual of this fine species of *Blaps* running toward us from the feet of the crowd. The act of impaling this unlucky fugitive at once conferred upon me the respectful and mystic title of 'medicine-man' from the superstitious faith of that simple people."

Say's two principal works, published separately, were his "American Entomology" in three volumes (Philadelphia, 1824–1828), with fifty-four colored plates; and his "American Conchology," of which only six parts appeared previous to his death. The work on entomology was a credit to himself and to the printer, while almost the only merit possessed by the latter work was the fine plates from the pencil of Mrs. Say. Mr. Say's other published papers will be found in the "Journal of the Academy of Natural Sciences of Philadelphia," "Transactions of the American Philosophical Society," "Maclurean Lyceum," "Nicholson's Encyclopædia," "American Journal of Science and Art," "Western Quarterly Reporter," reports of Long's expeditions, and several papers which were published separately at New Harmony. His entomological papers have been collected and reprinted, with annotations, by Dr. J. L. Le Conte, in two octavo volumes (New York, 1869).

Besides the work which appears in connection with his own name, almost all of the publications of Prince Charles Lucien Bonaparte, while in America, were corrected and arranged for the press by Say. This and other work made such calls upon his time that almost all of his own work was the product of the midnight hours; and this, in connection with his wicked disregard of the demands of his stomach, so undermined his constitution that, when attacked by a fever in his Western home, he had not the strength to rally, and on October 10, 1834, he passed away.

According to the testimony of all who knew him, Mr. Say was a most pleasant and agreeable companion, a thorough student, and a man of the most unpretentious manner. Always ready to assist a friend, his stores of knowledge were freely opened to those who asked, and information was cheerfully granted to all inquirers.

ENTERTAINING VARIETIES.

—— *Spanish Enterprise.*—Peter Bayle holds that it is sufficient for the glory of a nation to have produced one superlative man in every department of human merit, and by that rule the Spaniards can hardly be charged with a want of enterprise. At the beginning of the sixteenth century, when the *autos-da-fé* of the Infallible Church had turned Southern Europe into a moral cinder-heap, a Spanish gentleman, by the name of Saavedra, and possibly a relative of the immortal Miguel, resolved to profit by the prevailing tendency of the age and graft his fortune upon the one flourishing branch of human industry. After devoting a few years to the art of counterfeiting handwritings and the selection of discreet accomplices, he suddenly appeared at Lisbon with a train of a hundred and twenty followers, and presented his credentials as a papal plenipotentiary. The spread of heresy, he informed the astonished king, called for extraordinary measures, and his Holiness had resolved to invest the Casa Santa with discretionary powers, and had sent him as a special legate with instructions to institute immediate proceedings against the prominent heretics, Moslem and Jews, of the kingdom. Some three thousand persons were summoned before the new tribunal, and, while the bewildered authorities prepared a protest against the threatened innovation, the bailiffs of the legate had arrested six hundred suspects, and forcibly collected two hundred thousand crowns as fines for contempt of court. When the relatives of the prisoners expostulated in rather emphatic terms, the legate expressed his regret at the necessity of fining them too; and, when the discontent threatened to assume the form of a general revolt, the plenipotentiary considered it his painful duty to arrest the ringleaders as abettors of heresy, and, after a formal trial and the confiscation of their property, three hundred of the malcontents were actually burned at the stake, June, 1539. The tribunal was just preparing to fine the entire city of Lisbon, when by some indiscretion of a tax-collector the imposture was discovered, but, when the citizens flew to arms, the man of God had disappeared. He was afterward captured near Seville and sent to the galleys, but, in consideration of his zeal in behalf of the holy faith, he was soon pardoned, and the Pope, moreover, confirmed the decrees of the extemporized tribunal, and, as Voltaire remarks, thus rendered sacred what before was merely human.

—— *Had the Ancients Cheap Books?*—Mr. S. E. Dawson remarks, in his lecture on copyright, that it is a very common error to suppose that the ancient world was very badly supplied with books—to transfer to the times of Greek, Roman, and Egyptian civilization the darkness and dearth of mediæval Europe. The fact is, that in those days every gentleman's house had its library and every city had its *public* library. In every wealthy household was a servant to read aloud and another to copy books. Atticus, Cicero's friend, kept a large number of slaves transcribing, and made a good deal of money by the sale of the books so manufactured. In those days a publisher or bookseller kept a staff of skilled slaves. When a book was to be published one of these read and the others wrote, and in that manner, by the means of cheap slave-labor, large editions of books were published. The literary activity of the countries round the Mediterranean was very great, and we underestimate it. Horace has preserved for us

the names of the booksellers in whose shops he used to lounge. Martial refers a shabby fellow called Lupercus (who wanted to borrow his epigrams) to his bookseller Atrectus. He tells him the shop is "opposite the forum of Cæsar, and placards are posted outside giving the names of poets," evidently as is the custom of booksellers to this day. The price of the volume—the first book of his epigrams—he says is five denarii, equivalent to three shillings and sixpence sterling. Now, this first book contains one hundred and nineteen epigrams, or over seven hundred verses. It appears elsewhere that cheaper copies were provided. Martial refers to copies well rubbed with pumice and adorned with purple. The cheaper copies could be had at half that price, but this was in the best style. So that if we compare the price with the published price in England of "Maud," or any of the original small volumes of Tennyson's poems, which were issued at five or six shillings, the Roman publisher does not seem to be much dearer than the English one.

—— The first evidence on record of an *author's right of copy* is in the case of "Paradise Lost." This transaction is usually misrepresented. The bargain was that Simmons was to pay £5 cash, £5 more when thirteen hundred copies were sold, and £5 each for the second and third editions. It took seven years to sell the first thirteen hundred copies, and in 1680 Milton's widow sold her interest for £8 more.

—— In reference to his *conversion*, *Sir Charles Lyell* says: "The question of the origin of species gave me much to think of, and you may well believe that it cost me a struggle to renounce my old creed. One of Darwin's reviewers put the alternative strongly by asking 'whether we are to believe that man is modified mud or modified monkey.' The mud is a great come-down from the 'archangel ruined.' Even in ten years I expect, if I live, to hear of great progress in regard to 'fossil man.'"

—— *Broderip* says that, in spite of all the dogs and cats which float down the Thames, none of their remains have been found in recent excavations in the Thames deposits.

—— *An Earthly Paradise.*—Unless the Garden of Eden was planted in the very happiest latitude, the work of the gods seems for once to have been excelled by the achievement of a mortal. Toward the end of the tenth century, Abderrahman III, the Caliph of Cordova, conceived the idea of turning a whole mountain-range into a pleasure-park. On the heights of the Sierra de Peñas he built the famous Hischam Russáva, the summer-castle, with a pedestal of massive terraces girt with lakes and artificial cascades. The western slope of the Sierra, according to Ibn Caldir, an area of forty square leagues, was planted with all the trees known to the Arabian botanists—palms, laurels, chestnuts, oaks, and mountain-firs—all ranged in groves at different altitudes, according to the higher or lower latitude of their natural habitats. Ship-loads of foreign plants were landed at the harbor of Alicante, and the transport of these botanic cargoes is said to have employed sixty caravans for more than four years. "Not Shiraz, nor Araby the Blest, had such a wealth of odoriferous shrubs," says the historian; roses trained into trees, copses of lilac and jasmine-bushes loaded the air with perfume, and the Cordova gardeners seem to have known a method for ripening winter crops without hot-houses, for the orchards of the lower slopes furnished a perennial supply of fresh fruit. On the upper levels the Caliph had his game-preserves in vast plantations of *pinabetes*, a sort of Alpine fir that formed almost impenetrable thickets, while the highest crest of the Sierra was

laid out in pleasure-walks, mountain-meadows alternating with groups of cedar-trees and rocky *altamiras* or lookout-places. Special buildings had been provided for the acclimatization, or rather localization, of whole colonies of singing-birds, which were bred in-doors for a number of years till they were tame enough to be trusted at large. From the summer-palace, at an elevation of three thousand feet over the level of the Guadalquivir, an avenue led down to the east gate of Cordova by such nice gradations that the road-bed seemed to be a perfect level, and from various directions shady trails, apparently artless, but equally well graded, wound up to the summit of the mountain-range, where the Caliph had an astronomical observatory.

Landgrave Wilhelm of Hesse-Cassel built his mountain-palace on the proceeds of six thousand of his faithful subjects, sold to England at sixty-five pounds apiece, but Abderrahman III had no need of killing his fowls to get their eggs. During the reign of the first three caliphs, Cordova was, next to Bagdad, the richest city of the world; the valley of the Guadalquivir contained thirty-six towns and eighteen hundred prosperous villages, and the contemporary historians of the West vie in extolling the beauty and luxuriance of the *Boscál*, the orchard-region that surrounded the Moorish capital with a wreath of evergreen gardens.

The Sierra de Peñas is now a naked rock, Cordova a labyrinth of ruins, infested with pigs and begging friars, and the observatory of the impious Unitarians has been turned into a shrine of San Isidro. The Boscál has become a sandy desert, but on the south side of the river there are still some good bottom-lands, and the thrice-blessed cherry-trees of the orthodox peasants continue to yield an excellent kind of brandy.

—— *Starting a New Religion.*—Professor Seeley remarks, in his new book on "Natural Religion": "It is said that the theophilanthropist Larevellère-Lepeaux once confided to Talleyrand his disappointment at the ill-success of his attempt to bring into vogue a sort of improved Christianity, a benevolent rationalism which he had invented to meet the wants of a skeptical age. 'His propaganda made no way,' he said. 'What was he to do?' he asked. The ex-bishop politely condoled with him, feared it was indeed a difficult task to found a new religion, more difficult than could be imagined—so difficult that he hardly knew what to advise. 'Still'—so he went on after a moment's reflection—'there is one plan which you might at least try: I should recommend you *to be crucified and rise again on the third day!*'"

—— *Seeley on Theological Differences.*—"Why should we be so willful as to forget that the error of monstrously overestimating doctrinal differences has been all along the plague of theology? There can be no greater mistake than to measure the real importance of a dispute by the excitement of the disputants. It has often been remarked of theological controversies that they are never conducted more bitterly than when the difference between the rival doctrines is very small. This is nearly correct, but not quite. If you want to see the true white heat of controversial passion, if you want to see men fling away the very thought of reconciliation and close in internecine conflict, you should look at controversialists who *do not differ at all*, but who have adopted different words to express the same opinion."

—— *Origin of the Arab Horse.*—Letter of the Emir Abd-el-Kader, from "The Horses of the Sahara," by General E. Dumas, 1857:

"Praise be to the one God!

"To him who remains ever the same amid the revolutions of this world:

"To our friend General Dumas.

"Peace be with you, through the mercy and blessing of Allah, on the part of the writer of this letter, on that of his mother, his children, their mother, of all the members of his family and of all his associates.

"To proceed: I have read your questions, I address to you my answers.

"You ask me for information as to the origin of the Arab horse. You are like unto a fissure in a land dried up by the sun, and which no amount of rain, however abundant, will ever be able to satisfy.

"Nevertheless, to quench, if possible, your thirst (for knowledge), I will this time go back to the very head of the fountain. The stream is there always the freshest and most pure.

"Know, then, that among us it is admitted that Allah created the horse out of the wind, as he created Adam out of mud.

"This can not be questioned. Several prophets—peace be with them!—have proclaimed what follows:

"When Allah willed to create the horse, he said to the south wind:

"'I will that a creature should proceed from thee—condense thyself!' and the wind condensed itself. Then came the angel Gabriel, and he took a handful of this matter and presented it to Allah, who formed of it a dark bay or a dark chestnut horse (*koummite*—red mingled with black), saying:

"'I have called thee horse (*frass*); I have created the Arab, and I have bestowed upon thee the color *koummite*. I have attached good fortune to the hair that falls between thy eyes. Thou shalt be the lord (*sid*) of all other animals. Men shall follow thee wheresoever thou goest. Good for pursuit as for flight, thou shalt fly without wings. Upon thy back shall riches repose, and through thy means shall wealth come.'

"Then he signed him with the sign of glory and of good fortune (*ghora*, a star in the middle of the forehead)."

—— *Carlyle on Liberty.*—Caroline Fox, in her "Memories of Old Friends," gives a vivid sketch of her last meeting with Carlyle, whose "look and most of his talk were so dreary," at Mentone. After railing "at the accursed train, with its devilish howls and yells, driving one distracted," Carlyle went on: "Oh! this cry for liberty! liberty!—which is just liberty to do the devil's work, instead of binding him with ten thousand bands—just going the way of France and America, and that sort of places. Why, it is all going down-hill as fast as it can go, and of no significance to me—I have done with it. I can take no interest in it at all, nor feel any sort of hope for the country. It is not the liberty to keep the ten commandments that they are crying out for—that used to be enough for the genuine man—but liberty to carry out their own prosperity, as they call it. And so there is no longer anything genuine to be found. It is all shoddy. Go into any shop you will, and ask for any article, and ye'll find it all one enormous lie. The country is going to perdition at a frightful pace. I give it about fifty years yet to accomplish its fall."

EDITOR'S TABLE.

WEALTHY SCIENTIFIC INVESTIGATORS.

THE appearance of Sir John Lubbock's remarkable book on "Ants and Bees" has awakened some interesting discussion as to why there are not more such authors, and why, especially, we have no representatives of the class in this country. Sir John Lubbock is a man of wealth, who could, if he pleased, "enjoy" his liberal means—that is, spend his time in dignified idleness or elegant amusement; but he finds his pleasure, on the contrary, in all kinds of hard work, and, although he takes abundant relaxation, he never wastes an hour. The "Scientific American" remarks that we have a wealthy, idle class of men, who have no need to labor with hand or head, and who are free from every care. But, impelled by fashion, hundreds of such young men are to-day scouring the Adirondacks, or shooting the rapids of the St. Lawrence, and boring themselves to death in quest of amusement, because "it is quite the thing, you know." Here is the material from which naturalists and independent investigators of nature ought to be recruited in this country.

To such men Sir John Lubbock has set a noble example. Something—much, indeed, is to be first of all allowed to genius, but more is to be allowed to a dominant purpose, and the unremitting assiduity which is pleasurable when there is a cultivated interest in the subject. There is an all-sided activity in this case which is quite remarkable. To begin with, Sir John Lubbock is by profession a banker, and so thoroughly a man of business as to be not only a successful money-maker, but a leading reformer of the English banking system. His important work in this direction is thus well summed up in the "Whitehall Review":

> He has made two great landmarks in the history of banking which will always be associated with his name. One of these is the bank holiday; the other, the institution of the clearing-house of country banks, by which the benefits long known in the city of London were extended to all parts of the country. All the honors that the banking world could confer upon him have been liberally bestowed. He is the president of the Institute of Bankers, with its two thousand members, and holds the peculiar and remarkable position of honorary secretary of the London Association of Bankers. He is thus the medium between the banks and the Government, and the chosen exponent of the views of bankers in relation to Government. Then, he has instituted a system of examination for bankers' clerks corresponding to the civil-service examinations. Sir John was a member of the International Coinage Committee appointed by Government, and he is the author of a great variety of papers in financial literature.

And yet all this is but the subordinate and incidental part of Sir John Lubbock's work. He is pre-eminently a scientific investigator, and it is as such that he will be chiefly known in the future. A sagacious, patient, plodding observer of minute phenomena, he is at the same time a comprehensive original thinker, and had made a world-wide reputation by his researches into prehistoric archæology before he entered upon the systematic study of the social hymenoptera, the results of which are but just published.

If, now, we press the question why there are not more such men, particularly in this country, in the ranks of science, and helping forward its work, it will be an evasion to answer that it is for lack of native capacity or the talent for such labor. We have plenty of this good mind running to waste

that might do invaluable service in the extension and diffusion of scientific knowledge. The difficulty is a lack of sufficient interest in such things to resist other solicitations. We do not begin early enough with the study of science to form deep, persistent controlling impressions. Other subjects get the start, and the loss of ground can not be subsequently recovered. Sir John Lubbock recognizes that this is a great deficiency of education in England, and he has again and again brought forward measures in Parliament for extending and rationalizing scientific study in the primary schools, so as to lay a better foundation for this mental pursuit in later life. We suffer sorely from the same neglect. Our primary-school science is not genuine; it is book-science, and awakens no feeling or enthusiasm for the study of natural things. Our rich young men, however nominally educated, have never seriously taken hold of the study of nature, and, of course, care nothing about it. Intellectual ambition, therefore—and we have plenty of that—takes other directions. Two unregulated and overwhelming passions in this country stifle the growth of science: the intense and absorbing passion for wealth, and the universal infatuation for politics. These are great national diseases, not peculiar to America, but malignant in America, and the state of mind they engender makes the systematic cultivation of scientific thought next to impossible. Hence our education issues in money-making and politics as exclusive passions, with no cherished intellectual interests to counteract and restrain them. When our early scientific education becomes more perfected and better organized, so that a strong interest in the study of nature shall be enkindled in the minds of the young, we may then hope that American young men of affluence will be more inclined to seek their gratification in some of the varied and inexhaustible pursuits of scientific knowledge. As the "Scientific American" truly remarks:

> We have men of brains, of leisure, and of means, seeking in vain for some new way of getting rid of the most valuable thing on earth—time. But they are of no use to us or to science; let them finish their days as they have begun, let them listen to a few law lectures that they do not understand, or join some political party and set up for statesmen if they have money enough to buy an office. But shall this thing go on for ever? Is it not possible to cut off, in part at least, the source of supply by turning it to other channels? Many of these young men who have now no thought beyond the morrow, no higher ambition than to color a meerschaum, were boys once—real, genuine, inquisitive boys. Then their powers of observation were capable of cultivation, then a love of nature could have been implanted in their souls, and life would have been brightened by an object, and one worthy of a life-long pursuit. When teachers cease to hold up as models those great men who, like Lincoln and Garfield, have risen from poverty and obscurity to the presidency, and point with pride to the boys who, in spite of wealth and luxury, have had the courage and perseverance to do a noble act by devoting their time, money, and talents (for some rich boys have genius as well as poor ones) to the study of nature, when teachers begin to have common sense, we may hope to see some of this valuable material rescued from its present *downward* course. Rich men are not all fools, and there are some who would take pride in a son who, although he might not be a Leidy or a Lubbock, a Darwin or a Dawson, should be able to associate on terms of scientific equality with men of that class.

BEECHER ON THEOLOGY AND EVOLUTION.

The first article in the "North American Review" for August—an excellent number—is by Henry Ward Beecher, on "The Progress of Thought in the Church." It is an independent, a powerful, and a most significant discussion, which we recommend everybody to read. We shall not attempt to make any statement of the argument, and only call attention to the large and hearty recognition of science as an agency for the purification of religion.

The progress of thought in the Church is forcibly shown to be a result of the progress of science outside the Church. The distinction between religion and theology is not new, but Mr. Beecher shows that it is wide and deep, and that religion must unload theology or sink with it. The doctrine of evolution is not only broadly accepted, but its coming is hailed as the greatest event of modern religious progress. It is destined to do what nothing else could so effectually do to sweep out of the way and into oblivion the great body of old orthodox theological dogma, by which the human mind has been perverted and enslaved for ages. We quote two or three passages, which will illustrate the positions taken by Mr. Beecher. After a brief but vivid statement of the working of the law of evolution upward through the various spheres of natural phenomena, until man and his higher development are reached, Mr. Beecher says:

At this point there is a halt. It is perhaps the most revolutionary tenet ever advanced. It will be to theology what Newton's discoveries were to the old astronomy. The repugnance that men feel at descending along such a road, and with such an ancestry, would foam and subside in a short time. It is not the retrospect, but the prospect, which gives such almost universal hesitation to the mind and imagination of mere scientific moralists. Its admission would be fatal to the theory of a plenary and verbal inspiration of the Bible still held by some. The first two chapters of Genesis have been a sword in the hands of theologues of old with which to fight the discoveries of modern astronomy. Next they were sharpened against the advent of geology. In both conflicts God prevailed and the truth was victorious. Now again, but upon a more tremendous issue, theology resists evolution. It is an honest resistance. To admit the truth of evolution is to yield up the reigning theology; it is to change the whole notion of man's origin, his nature, the problem of human life, the philosophy of morality, the theory of sin, the structure of moral government as taught in the dominant theologies of the Christian world, the fall of man in Adam, the doctrine of original sin, the nature of sin, and the method of atoning for it. The decrees of God as set forth in the confession of faith, and the machinery supposed to be set at work for man's redemption, the very nature and disposition of God—as taught in the falsely called Pauline but really Augustinian theology, popularly known as Calvinistic—must give way.

The dread of Darwinian views is sincere; yet a secret fear prevails that they may be true. But have men considered what a relief they will be from some of the most disgraceful tenets of theology? Are they content to guard and defend a terrific scheme which sullies the honor, the justice, and the love of God against a movement that will cleanse the abomination and vindicate the ways of God to man? Even if the great truth of evolution led to unbelief, it could not be so bad as that impious and malignant representation of God and his government which underlies all mediæval and most of modern theology. We shall quote from the Presbyterian Confession of Faith the account given by the Church of the origin of man and of his moral government, in the light of which the scientific account of the origin of man and the nature of sin is as health to sickness, as life to death. Instead of dreading the prevalence of the scientific doctrine, Christian men should rush toward it with open arms and exultation as a release from the hideous nightmare of ages.

The tendency of recent scientific researches and disclosures respecting the mind of man and his origin and nature will be far more pronounced upon the theories of *theology* than upon the *institutions* of religion. Christian churches are legitimate organizations for the development of religious emotion and for the application of truth to our daily life. Those churches which are organized for *devotion* will be less disturbed than academical churches which have hitherto aimed only to expound and defend a creed. But churches whose genius it is to develop religious thought, as distinguished from religious emotion, will gradually change, and the devotional element will take the place largely of the theologic, and the ethical the place of the philosophical.

When the creeds of the past era have passed away, we shall enter upon the creeds of a new era. These will differ not alone in their contents from former doctrinal standards, but they will differ in the very genius and method of construction. Our reigning creeds begin with God, with moral government, with the scheme of the universe, with the great, invisible realm beyond. These are the weakest places in a creed, because the matters they contain are least within the

reach of human reason, and because the alleged revelations from God upon them are the most scanty and uncertain. The creeds of the future will begin where the old ones ended: upon the nature of man, his condition on earth, his social duties and civil obligations, the development of his reason, his spiritual nature, its range, possibilities, education—the doctrine of the human reason, of the emotions, of the will—man as an individual, man social and collective; and, from a sound knowledge of the nature of mind, developed within the scope of our experience and observation, we shall deduce conceptions of the great mind—the God idealized from our best ascertainments—in the sphere within which our faculties were created to act with certainty of knowledge. Our creeds will ascend from the known to the unknown, which is the true law and method of acquiring knowledge. Hitherto they have expended their chief force upon that which is but dimly known.

THE DARWIN MEMORIAL.

A MOVEMENT has been started in England to get up some kind of a memorial in honor of Mr. Charles Darwin. The English Executive Committee has requested the following American gentlemen to co-operate with them in promoting the object: Asa Gray, chairman; Spencer F. Baird, James D. Dana, Charles W. Eliot, D. C. Gilman, James Hall, Joseph Le Conte, Joseph Leidy, O. C. Marsh, S. Weir Mitchell, Simon Newcomb, Charles Eliot Norton, Francis A. Walker, Theodore D. Woolsey; Alexander Agassiz, Treasurer. Subscriptions may be sent to Alexander Agassiz, Cambridge, Massachusetts, who will acknowledge the same and forward them to the Treasurer of the English Executive Committee of the Darwin Memorial.

The American committee, in their circular, without date, say that the form which the memorial is to take has not yet been decided; it will probably include an endowment for a scholarship to carry on biological research. Nothing could be more appropriate to the character of the man whose memory is to be honored than thus to link his name with the progress of knowledge in the field which he has done so much to make his own. But the "Athenæum" announces that the memorial will take the customary form of a marble statue, and that the trustees of the British Museum will be asked to place it in the large hall of the museum at South Kensington. The English subscriptions are reported as amounting to $12,500. The United Kingdom will probably be able without help to pay for a marble statue; and would it not be well for the American committee to entertain the idea of doing something independently in this country? The endowment for a biological scholarship, if abandoned in England, might well be taken up here.

LITERARY NOTICES.

A GEOGRAPHICAL READER. Compiled and arranged by JAMES JOHONNOT, author of "Country School-Houses." New York: D. Appleton & Co. Pp. 416. Price, $1.25.

THE compiler believes that it is no disadvantage for the reading-lessons given to the pupil in school to be primarily directed to some subject of thought. "If the food is also palatable as well as nutritious," the pupil becomes interested and his mind engaged with the substance of the lesson, and he will gain all the advantages that otherwise cost so much labor, without direct and conscious effort. The reading exercises should also be adapted to the condition of the pupil's mind at each period of growth, and should constitute appropriate models of style, leading in the direction of literary excellence. Hence is suggested the propriety of introducing lessons bearing on some topic of study which the pupil is pursuing at the same time. Text-books give, necessarily, the bare outlines. The reading-books might help to fill up the outlines with details, giving fuller descriptions of the most interesting features, and the stories which the children love so well. When these supplementary elements are chosen from classic authors, we have what we might call an

ideal reading-book on the subject in hand. The present work is an attempt to apply these principles to geographical topics. The order of the topics is the same as is found in any well-arranged text-book on the subject; and the articles are from writers of acknowledged excellence. We have in twenty chapters selections on the several varieties of natural features and scenery, on the surface of the earth, volcanic and meteorological phenomena, natural curiosities, wild animals, national characteristics, peculiar customs, regions, and people, cities, ancient works and ruins, and modern works, etc., given in the form of essays, popular descriptions, narratives of travel, scientific accounts, and poems, by a list of writers embracing the names of European and American authors who have become distinguished in various fields of literature and science.

THE SCIENCE OF ETHICS. By LESLIE STEPHEN. New York: G. P. Putnam's Sons. Pp. 462. Price, $4.

THE author of this book has his own views of morality, and, although he does not profess to have made any great revolution in the science, he has still made a book which is worthy of careful consideration. It is an unusually spirited and attractive volume on what is commonly regarded as the dullest of subjects.

Mr. Stephen began as an orthodox utilitarian in morals, and avows that the Gamaliel at whose feet he sat was John Stuart Mill. This, however, he regards as an immature proceeding, in which he merely joined other thoughtful lads in deferring to one whose authority was decisive. At a later period his mind was much stirred by the appearance of Darwin's "Origin of Species." He acknowledges great indebtedness to Darwin's writings, but so far as ethical problems are concerned he came at length to think that the Darwinian resources were unsatisfactory, and that a deeper view was necessary—this conviction being due to the influence of Herbert Spencer's writings. After an historical examination of the English moralists of the eighteenth century, Mr. Stephen read the "Methods of Ethics," by Henry Sedgwick, and, although admiring the work, he found himself differing from it at so many points that he resolved to publish systematically upon the subject himself. Mr. Stephen regards the relation of evolution to ethics as its critical point, while Mr. Sedgwick belittled it, and thus left a great deal to be done in clearing up the inquiry.

Of his attempt Mr. Stephen says: "At times I have been startled at my own impudence when virtually sitting in judgment upon all the deepest and acutest thinkers since the days of Plato. But I easily comfort myself by remembering that the evolution of thought is furthered by the efforts of the weak as well as of the strongest; and that, if giants have laid the foundations, even dwarfs may add something to the superstructure of the great edifice of science. So far as my reading has gone, I have found only two kinds of speculation which are absolutely useless—that of the hopelessly stupid and that of the hopelessly insincere. The fool who does not know his own folly may be doing nothing, and the philosopher who is trying to darken knowledge may be doing worse than nothing, but every sincere attempt to grapple with real difficulties made by a man not utterly incompetent has its value. I claim to come within that description, though I claim nothing more. And I have the satisfaction—not a very edifying one, it may be said, for a professed moralist—to reflect that if my book does no good to anybody else, it has provided me with an innocent occupation for a longer time than I quite like to remember; while I hope that there is nothing in it—if I may apply to myself what a discerning critic has said of Dr. Watts's sermons—"calculated to call a blush to the cheek of modesty."

MODERN APPLICATIONS OF ELECTRICITY. By E. HOSPITALIER. Translated and enlarged by JULIUS MAIER. New York: D. Appleton & Co. 1882. Pp. 456. Price, $4.50.

IN the present state of public interest in the applications of electricity, any author who succeeds in presenting the subject in a popular manner may expect a favorable reception, and we doubt not such will be accorded to this latest addition to works of this character. M. Hospitalier's exposition is clear and concise, and popular enough in form to be interesting and intelligible to a wide circle of readers. The work consists

of four principal parts, in the first of which the author considers the sources of electricity—hydro- and thermo-electric batteries and machines—and also various apparatus for transforming currents, under which heading he places accumulators or secondary batteries. The second part is devoted to electric lamps—regulators, candles, and those producing light by incandescence. In the third division the subject of telephones and microphones is taken up, and all the later forms of these pieces of apparatus are described. In the fourth and final part there are considered various applications of electricity, such as devices for indicating fire-damp in coal-mines, fire-alarms, etc., the electrical transmissional power, electro-motors, and electric distribution.

While the book will be found in many respects an excellent popular *résumé* of the subject, it is not without defects, and lacks the completeness which a work of this character should at the present time possess. The daily as well as the technical press has familiarized most persons interested in the subject with the various types of lamps which have so far been developed, and the questions of interest now are mainly those of cost and the conditions upon which electric lighting in general depends. Much of the description of different forms of lamps of the same class might, therefore, have been dispensed with—such, for instance, as the various forms of candles and the lamps of imperfect contact, neither of which promise to have much of a future before them—and been given with advantage to incandescent lamps employing a carbon filament. The treatment of this class of lamps is, to say the least, meager, and that of the workers in this field far from satisfactory. One would hardly get a correct idea of the relation of Mr. Edison's work to the present successful results by the author's presentation of it. The treatment of the problem of distribution is hardly as full and complete as might be desired, or the work of M. Marcel Deprez in this direction as clear and as full as it should be. The work on the whole is, however, a very readable one, and will give those unacquainted with the recent advances in the industrial applications of electricity a fairly good idea of what has been so far accomplished.

AN ETYMOLOGICAL DICTIONARY OF THE ENGLISH LANGUAGE. By the Rev. WALTER W. SKEAT, M. A., of the University of Cambridge. New York: Macmillan & Co. Pp. 799. Price, $2.50.

THIS work may be regarded as in certain senses a pioneer in the field of literature to which it relates. The aim of the author has been to furnish students with materials for a more scientific study of English etymology than is commonly to be found in previous works on the subject. The older dictionaries were rich in quotations illustrative of the words they defined, but their etymologies were defective and of the crudest kind, being in most cases thoroughly unscientific guess-work, and most likely wrong. In many instances, Mr. Skeat says, he has found evidence that the dictionary-makers manufactured words for the express purpose of deriving others from them. The earlier editions of Webster's "Dictionary" gave the corresponding words and the one under consideration from a great number of languages, without any discrimination based upon the possibility of their having or not having a real relation with the English word. Such comparison was, perhaps, interesting as a curiosity, but was confusing to etymological students, and could give no clew to the derivation of the word. Better work has been done in the later editions of Webster, in which Dr. Mahn's etymologies deserve and receive commendation; but the plan of the work, says Mr. Skeat, "does not allow of much explanation of a purely philological character." In preparing his work the author has been guided by certain canons, a few of which, such as commend themselves to the general reader, are: Before attempting an etymology, ascertain the earliest form and use of the word, and observe chronology, observe history and geography, observe phonetic laws. The whole of a word, and not a portion only, ought to be reasonably accounted for; mere resemblance of form, and apparent connection in sense between languages which have different phonetic laws, or no necessary connection, are commonly a delusion, and are not to be regarded; and it is useless to offer an explanation of an English word which will not also explain all the cognate forms. The attempt is made to give the exact history of

each word, and, to make its pedigree complete, it is traced through all the ascertained successive changes, in their order, which it has passed through in the several languages through which it has come down, as if by descent, to us. Thus, in the case of the word "canopy," it is shown, by the brief, clear notation which is adopted throughout the book, that the word is derived in English from the French, the French from the Italian, that from the Latin, and that from the Greek; and if the ultimate Aryan root can be deduced, that is indicated. This, Mr. Skeat believes, is the first attempt of this kind that has been made, except partially. Another notation, equally simple and plain, shows cognate forms and distinguishes them from descending forms. Many of the articles are quite full histories, and all are rich in suggestions to the thoughtful student. Mr. Skeat frankly confesses to a number of short-comings. The remark to be made about them is not so much that they exist, as that the author should take the pains to call attention to them. On review they appear generally to be such as must inevitably beset the student who has to undertake so large a subject alone, or such as every one who attempts to advance into so extensive a field, that has been heretofore so little or so unskillfully cultivated, must expect to be liable to.

OUR MERCHANT MARINE: HOW IT ROSE, INCREASED, BECAME GREAT, DECLINED, AND DECAYED; with an Inquiry into the Conditions essential to its Resuscitation and Future Prosperity. By DAVID A. WELLS. New York: G. P. Putnam's Sons. Pp. 219.

PROFESSOR WELLS undertakes a diagnosis of the disease with which our merchant marine is afflicted, through the operation of which, from having once been our pride and boast, it has fallen in the course of a quarter of a century into a contemptible insignificance; or, to illustrate the subject by figures, from carrying in 1855 75·5 per cent of the imports and exports of the country, by steady diminutions to carrying only 16·2 per cent of them in 1881. The most direct cause of decay is found in our navigation laws, under which the privileges essential to the prosperity of an American merchant marine are confined to American-built vessels, and denied to all ships bought abroad. In connection with this cause others are operating which bear with peculiar hardship on American vessels and American ship-building enterprises, such as high duties on imported materials used in ship-building, and various local burdens, in the imposition of which a positive discrimination appears to be made against American vessels. Back of these causes and under some of them lies the fundamental cause, in the protective system, some of whose most positive advocates have avowed the belief that the policy of the country is to discourage commerce, and the provisions of which have been adjusted, whether designedly or not, in consistency with this belief. No one measure, the author concludes, "will arrest the decay of American shipping, bring back prosperity to our ocean carrying-trade, or revive the industry of ship-building in this country. The field of reform to be entered upon is a very large one; the number of details which are to be attended to are numerous; but reform, nevertheless, is both possible and practicable if the American people desire and will it." He then mentions the most essential measures of reform, the nature of which is indicated generally by the references we have made to the evils that demand a remedy.

SCIENCE LADDERS—No. I. FORMS OF LAND AND WATER. Pp. 67. No. III. VEGETABLE LIFE. Pp. 78. By N. D'ANVERS, author of "Heroes of North African Discovery," etc. Both illustrated. New York: G. P. Putnam's Sons. Price, 50 cents each.

THE author states that his design in planning the series of which these works are a part has been to teach the great laws of Nature in language simple enough for every child to read, and to awaken the powers of observation and reasoning by means of purely elementary descriptions. "The Forms of Land and Water" gives descriptions of the earth and its general features and phenomena. "Vegetable Life" is intended to teach the laws of the life and growth of plants and to serve as an introduction to elementary botany. The effort has not been a happy one. The style is childish instead of simple, and is calculated to lead to inexactness and confusion; pains are taken to give a knowledge

of scientific terms and their definitions which should rather have been applied to the communication in really plain language of the facts which the words indicate. The matter is above the comprehension of the kind of children for whom the style seems to be intended, and the style is not adapted to the tastes of larger ones. The illustrations are excellent.

THE GOSPEL OF LAW. A SERIES OF DISCOURSES UPON FUNDAMENTAL CHURCH DOCTRINES. By S. J. STEWART. Boston: George H. Ellis. Pp. 326. Price, $1.25.

THE author is pastor of the Independent Congregational Society of Bangor, Maine. The substance of the volume was originally delivered as a series of regular Sunday discourses before his people. The principal motive of the book is stated to be "to apply the facts of science to inherited doctrines, and then to give a positive basis of belief and conduct in consistency with these facts, to interpret the results of the best authorities, and to bring them into a practical form and conclusion." The author apparently belongs to the advanced rank of "free religious" thinkers. He denies the supernatural character and authority of the "Church of tradition," and of its gospel, and would substitute for the latter a "gospel of law," the fundamental principle of which is that every effect is the natural product of some natural cause.

MANUAL OF OBJECT-TEACHING, WITH ILLUSTRATIVE LESSONS IN METHODS AND THE SCIENCE OF EDUCATION. By N. A. CALKINS. New York: Harper & Brothers. Pp. 469. Price, $1.25.

THE author of this book is and has long been one of the Superintendents of the Public Schools of the city of New York, and the supervision of object-lesson studies falls within his department. His writings upon that subject have, therefore, a broad basis of experience, involving the trial of methods and the improvement and extension of the objective system. Mr. Calkins published, some years ago, the "Primary Object Lessons," which has been well received and generally adopted. The new work now issued—the "Manual"—extends over a broader field, and embraces subjects and methods for more advanced teaching than those presented in the author's earlier work. It is, therefore, not a substitute for that book, nor a revision of it, but an entirely new treatise, with a great variety of appropriate topics, materials, and suggestions to aid teachers in oral instruction. In this line Mr. Calkins's books are authorities at the present time.

HINTS AND REMEDIES FOR THE TREATMENT OF COMMON ACCIDENTS AND DISEASES; AND RULES OF SIMPLE HYGIENE. In Two Parts, complete. Compiled by DAWSON W. TURNER, D. C. L., late Head-master of the Royal Institution School, Liverpool; sometime Student of Westminster Hospital and of Charing Cross Hospital. Revised, corrected, and enlarged by Twelve Eminent Medical Men belonging to Different Hospitals in London, and by one Right Reverend Bishop of the Established Church, formerly Surgeon to one of the London Hospitals, and F. R. C. S. With numerous Additions, from the eighth English edition. New York: Macmillan & Co. Pp. 106. Price, 50 cents.

A BOOK so well backed and braced by authorities as this may seem to need no commendation from us; but a careful examination of it has shown that it is a most practical, judicious, carefully considered digest of hygienic rules and hints about health which is well calculated to be useful to everybody.

GOOD CHEER. A Monthly Paper devoted to Home Science and the Interests of the Family generally. Greenfield, Massachusetts: Good Cheer Publishing Company. Pp. 16. 50 cents a year.

THIS new venture in the literary field is bright, varied, and spicy, and the best newspaper bargain for the family now a-going at fifty cents. There is a practical turn about it that is promising, and its scientific side will probably improve with time. The mechanical style of its title, however, seems open to criticism. An artist has been let loose upon it, and the consequence is obscurity. A title, of all things, should be clear, and not so buried up in artistic beauty that we have to spend time digging out what it means. Give us clear, plain, sharp lettering that tells its whole story at the first glance, and let the artist revel in the advertisements.

COPYRIGHT IN BOOKS: An Inquiry into the Origin and an Account of the Present State of the Law in Canada. A Lecture delivered before the Law School of Bishop's College at Sherbrooke. By S. E. DAWSON. Montreal: Dawson Brothers. Pp. 40, with Appendix.

THIS is a very instructive address, by one who is well up in copyright erudition. The account of the origin of copyright is particularly excellent, while the exposition of the present state of copyright law and practice in Canada, and how the policy of the home Government has borne upon the British Provinces, will be of interest to all who are concerned about this subject.

It is curious to note how the first institution which was invested with the control of publication in England, by which authors' rights in their books were protected, was established as a means of maintaining religious orthodoxy. The Stationers' Company, which, like all the other ancient trading guilds, had existed from the middle ages, received a chartered extension of its powers "to search out and destroy" books printed in contravention of the company's monopoly, "or against faith and sound doctrine." On this point Mr. Dawson observes:

No record exists of authors' rights having been claimed for more than one hundred years after the invention of printing. There was no restriction in printing books, any more than there had been in copying manuscript books. Every printer printed what he chose, without let or hindrance from any person. At the end of that period, however, the enormous power of the press became manifest. The stir of thought which produced the Reformation had been caused, and was kept up, by the art of printing; and when Philip and Mary came to the throne of England they set themselves to stem the tide of innovation. For that purpose they incorporated the Stationers' Company by royal charter for licensing and regulating the printing and sale of books, and they vested in this company a monopoly of multiplying copies. The preamble to the charter sets forth its object. It reads:

"Know ye, that we, considering and manifestly perceiving that several seditious heretical books, both in verse and prose, are daily published, stamped and printed, by divers scandalous, schismatical, and heretical persons, not only exciting our subjects and liege-men to sedition and disobedience against us, our crown, and dignity, but also to the renewal and propagating very great and detestable heresies against the faith and sound Catholic doctrine of Holy Mother the Church, and being willing to provide a remedy in this case," etc.

A PRACTICAL TREATISE ON DISEASES OF THE SKIN. By LOUIS A. DUHRING, M. D., Professor of Diseases of the Skin in the Hospital of the University of Pennsylvania; Dermatologist to the Philadelphia Hospital; Consulting Physician to the Dispensary for Skin Diseases, Philadelphia; Author of the "Atlas of Skin Diseases," etc. Third edition, revised and enlarged. J. B. Lippincott & Co. Pp. 684. Price, $6.

A THIRD edition of this excellent work having been called for, the approbation of the profession must be taken as determining it to rank as one of the standards of medical literature. The plan of the work is that of a practical treatise, which, while making no pretension to being exhaustive, yet comprises sufficient to afford a clear insight into the elements of dermatology, and a knowledge of the important facts in connection with each disease treated of. The progress of dermatological science, in both its physiological and pathological aspects, has been very rapid in recent years, which makes indispensable the frequent revision of works on skin-diseases. The second edition of this work was accordingly carefully rewritten and much extended. The third edition has also been critically revised, and brought sharply up to date. The chapter on the anatomy and physiology of the skin has been rewritten and elaborated, this change being demanded by the recent studies in microscopic anatomy. The book as a whole has also been considerably enlarged. Numerous additions in the way of cases illustrating rare forms of disease, new and important observations, personal experience, and therapeutical information, will be found upon almost every page.

ERRORS IN THE USE OF ENGLISH. By the late WILLIAM B. HODGSON, LL. D., Fellow of the College of Preceptors and Professor of Political Economy in the University of Edinburgh. American revised edition. Pp. 246. Price, $1.50.

THERE are few things to be done in this world that can not be overdone, and among the things that can be studied out of all proportion to their importance are the exquisite niceties and transcendental refinements of language. The danger of excess here is, however, because a high standard of excellence is justly demanded. Dr. Hodg-

son's book recognizes the need of adopting such a standard in the study of English; and, what is more important, it adopts the right plan to secure this as a practicable thing. The author's principle is that example is better than precept, and instead of working up a lot of rules to be learned and applied, his book consists of examples of the erroneous use of language, from many and reputable sources. He points out errors, faults, and blunders in composition, but he shows that all writers—even the best—have their lapses. The book is very interesting and teaches in the best manner by concrete illustrations of the errors to be avoided. Dr. Hodgson was a man of fine literary taste, very widely read, and methodical in his observations; he has accordingly enriched his book with a host of examples of incorrect language, commonly overlooked, which will be of invaluable service to the critical students of English.

Mrs. Hodgson appends the following note to the preface: "The materials of this little volume were selected by my husband from his notes of many years' extensive and varied reading, and they were arranged for publication in their present form before his death. In now conducting the book through the press I have had the assistance of kind friends to whom his memory is dear. But, deprived of his own revisal, there may be errors and imperfections that have escaped our notice, and for such I must ask the reader's considerate indulgence."

This incompleteness or lack of finish in the volume on the part of the author made desirable a critical revision of the American edition; this has been done by Mr. Francis A. Teall, with excellent judgment and discrimination.

AMERICAN COLLEGE DIRECTORY AND UNIVERSAL CATALOGUE. Published by C. H. Evans & Co., Managers of the American Teachers' Bureau, St. Louis. Pp. 168. Price, $1.

THE Directory contains descriptions of more than 3,600 institutions of every kind, from the Kindergarten to the university, throughout the United States, with lists of State, city, and county school-officers and educational periodicals; a synopsis of the public-school system; a sketch of education in foreign countries; and much other valuable matter. The present volume is the fourth in annual series; it has been prepared under such advantages as it is believed make it more full and accurate than its predecessors, and is enriched with four new departments—those of "College Y. M. C. A.," city superintendents, county superintendents, and the foreign department, which embraces the comparative statistics of elementary education in fifty different countries.

WHAT IS BRIGHT'S DISEASE? ITS CURABILITY. By SETH PANCOAST, M. D. With Illustrations. Philadelphia: Published by the author, 917 Arch Street. Pp. 152. Price, $1.

THE author maintains that the view of Bright's disease as a local disease and its treatment under that view are mistaken. He advances the idea that the primary cause of the disease lies in the organic nervous system, which controls the nutrition and growth of the entire organism, as well as the elimination of the products of disintegration; that it may exist for many months, if not years, before albumen is detected in the urine; and that then other organs are involved, not from sympathy with the kidneys, but from innervation of the nervo-vital energy. He has found it curable when treated in the light of his theory, provided the disorganization has not proceeded too far.

KANT'S CRITIQUE OF PURE REASON: A CRITICAL EXPOSITION. By GEORGE S. MORRIS, Ph. D., Professor in the University of Michigan. Chicago: S. C. Griggs & Co. Pp. 272. Price, $1.25.

THE present volume is the first of a series of "German Philosophical Classics for English Readers and Students," to be issued by the publishers under the general editorial supervision of Professor Morris, each volume of which will be devoted to the critical exposition of some one masterpiece of German philosophical thought. The editors will seek in each case to furnish a clear and attractive statement of the special substance and purport of the original author's argument, with interpretations and elucidations in the light of the historic and acknowledged results of philosophic inquiry, and independent estimates of the merits and deficiencies of his work, and they will have especial ref-

erence to its relations with British speculation. Besides the general editor, several eminent scholars and teachers have been invited to prepare particular volumes of the series. The prominence of Kant among modern philosophers and the general merits of his work make it eminently fitting that he be given the first place in the series. His thoughts certainly deserve and need to be set forth in a shape in which they may be accessible and intelligible to the average of thinking readers. Professor Morris has undertaken this task in the face, he acknowledges, of considerable difficulties, among which are that "Kant's work marks and conspicuously illustrates a stadium of transition in the history of modern thought," that "it is far more eminently the story of a process of inquiry and demonstration than a didactic exposition of finished results," and that "Kant's intellectual attitude, in some of its most essential aspects, remains, to the end, thoroughly confused."

THE PSYCHOLOGY OF THE SALEM WITCHCRAFT OF 1692, AND ITS PRACTICAL APPLICATION TO OUR OWN TIME. By GEORGE M. BEARD, A. M., M. D. New York: G. P. Putnam's Sons. Pp. 112. Price, $1.

DR. BEARD'S essay has less immediate bearing on the Salem witchcraft than on the case of a murderer who was recently executed at Washington. The witchcraft excitement of 1692 is used as a pivot on which to hang a plea in behalf of the murderer. The people of New England were under a delusion when they tried and hung the Salem witches; so, it is argued, we have been under a terrible delusion in trying and hanging the murderer of our President.

GEOLOGICAL SKETCHES AT HOME AND ABROAD. By ARCHIBALD GEIKIE, LL. D., F. R. S. New York: Macmillan & Co. Pp. 335. Price, $1.75.

PROFESSOR GEIKIE is a very sound geologist, but we are inclined to think he is more at home in the work of exploration than in that of essay-writing. The papers of this collection are all good and solid, and will interest those already instructed in its line of topics, but they have not a large share of the quality which will attract general readers.

UNSCIENTIFIC TREATMENT OF THE INSANE.—In his paper on "Insanity in its Relations to the Medical Profession and Lunatic Hospitals," Dr. Nathan Allen points out several serious defects in the management of our hospitals for the insane. The first of his objections is to the separation of the experts from the medical profession and the placing of the study of insanity and the care of the insane so exclusively in their hands. A second fault is in the erection of so large and expensive buildings, by which a multitude of difficulties, avoidable in the multiplication of smaller establishments, are encountered. The system itself, moreover, is wrong, in that it aggregates such large masses of diseased persons; and it violates sanitary laws by bringing the diseased in contact with each other, to infect each other with the most infectious of all disorders—those of the mind. A fifth objection is that the magnitude of the congregations precludes the employment of the highest order of sanitary agencies for the health and improvement of the patients. Finally, it is objected that the present system tends directly to confine the knowledge and treatment of insanity to a few individuals. Add to this that no plans are devised or means employed to prevent insanity, and we have abundant reason, Dr. Allen thinks, to revise our system.

PUBLICATIONS RECEIVED.

The Prehistoric Architecture of America. By Stephen D. Peet. Reprint from the "American Antiquarian." Pp. 16.

The Prevention of Yellow Fever. By Professor Stanford E. Chaille, M. D. New Orleans: L. Graham & Son, Printers. 1882. Pp. 22.

The Culture and Management of our Forests. By H. W. S. Cleveland. Springfield, Ill.: H. W. Rokker, printer. 1882. Pp. 16.

Tenth Census of the United States. Forestry Bulletins Nos. 1 to 16. With Special Reference to the Lumber Industry. December, 1881.

The Fifty-eighth Annual Report of the Officers of the Retreat for the Insane of Hartford, Connecticut. Hartford. 1882. Pp. 35.

Consumption: Its Causes, Prevention, and Hygienic Management. By W. H. Smith, M. D., Ph. D. St. Clair, Michigan. Pp. 11.

Report on Surgery. By W. O. Roberts, M. D. Reprint from the "American Practitioner," Louisville. 1882. Pp. 16.

Socialism and Christianity. By H. Cheroung. Printed by the Author. New York. 1882. Pp. 42. 15 cents.

Account of Field Experiments with Fertilizers. By Professor W. O. Atwater. From the Report of the Connecticut Board of Agriculture. 1881. Pp. 25.

Coöperative Experimenting as a Means of studying the Effects of Fertilizers and the Feeding Capacities of Plants. By Professor W. O. Atwater. Washington: Government Printing-Office. 1882. Pp. 33.

Anlagen von Hausentwässerungen nach Studien americanischer Verhältnisse. [Elements of House-Drainage, after Studies of American Arrangements.] Mitgetheilt von W. Paul Gerhart, Civil Engineer, Newport, R. I. Berlin, 1880: Polytechnische Buchhandlung, A. Seydel. Pp. 38, with Five Plates.

House-Drainage and Sanitary Plumbing. Providence, R. I., 1882, pp. 104; and Diagram of Sewer Calculations, Newport, R. I., 1881, pp. 7. By William Paul Gerhart, Civil and Sanitary Engineer.

An Organ-Pipe Sonomoter. By W. Le Conte Stevens. Reprint from the "Journal of the Franklin Institute," July, 1882. Pp. 5.

Physiological Perspective. By W. Le Conte Stevens. From the "Philosophical Magazine," May, 1882. Pp. 17.

Two Cases of Hemi-Achromatopsia. By Henry D. Noyes, M. D. New York. 1882. Pp. 12.

Second Annual Report of the Astronomer in charge of the Horological and Thermometric Bureaus in the Observatory of Yale College. By Leonard Waldo. New Haven. 1882. Pp. 16.

Dangerous Illuminating Oils. By J. K. Macomber. State Agricultural College. Ames, Iowa. Pp. 6.

Plastic Splints in Surgery. By Samuel N. Nelson, M. D., Brooklyn, N. Y. 1882. Pp. 18.

Pro and Con of Spelling Reform. By Professor E. O. Vaile. New York: Burney & Co. 1882. Pp. 20.

Double Irrigation and Drainage Tubes; Uterine Dilatation by Elastic Force; The Cure of Hernia by the Antiseptic Use of Animal Ligature. By Henry O. Marcy, M. D. London: J. W. Kolckmann. 1881. Pp. 12.

First Annual Report of the Committee on the American School of Classical Studies at Athens. Pp. 13.

Professional Papers of the Signal Service: No. 1, Solar Eclipse of July, 1878, by Cleveland Abbe, 1881, pp. 186; No. 2, Isothermal Lines of the United States, 1871–1880, by Lieutenant A. W. Gruely, 1881; No. 3, Chronological List of Auroras observed from 1870 to 1879, by Lieutenant A. W. Gruely, 1881, pp. 76; No. 5, Information relative to the Construction and Maintenance of Time-Balls, 1881, pp. 71; No. 6, The Reduction of Air-Pressure to Sea-Level at Elevated Stations west of the Mississippi River, by Henry A. Hazen, A. M., 1882, pp. 42. Washington: Government Printing-Office.

Tenth Census of the United States; Statistics of Power and Machinery employed in Manufactures, by Professor W. P. Trowbridge: Water-Power of the Southern Atlantic Water-Shed of the United States, by George F. Swan, S. B. Washington: Government Printing-Office. 1881.

Action of Free Molecules on Radiant Heat, and its Conversion thereby into Sound. By John Tyndall, F.R.S. From the Philosophical Transactions of the Royal Society, Part I. 1882. Pp. 64.

Bird-Bolts: Shots on the Wing. By Francis Tiffany. Boston: George H. Ellis. 1882. Pp. 180.

Eliane. By Mme. Augustus Craven. From the French by Lady Georgiana Fullerton. New York: William S. Gottsberger. 1882. Pp. 340. 90 cents.

Studies in Science and Religion. By G. Frederick Wright. Andover: Warren F. Draper. 1882. Pp. 390.

Annual Report of the Chief Signal Officer to the Secretary of War for the Year 1879. Washington: Government Printing-Office. 1880. Pp. 782.

Practical Microscopy. By George E. Davis, F. R. M. S., etc. Second edition. London: David Bogue. 1882. Pp. 335. Illustrated.

POPULAR MISCELLANY.

Experiments in Ensilage.—Professor W. A. Henry, of the Experimental Farm of the University of Wisconsin, has published a report of an experiment in ensilage that was made last year under his direction. A pit was made, thirty feet long by fifteen wide and fifteen deep, with thick stone walls, at a cost of $413.12, and was filled to near the top with a crop of fodder-corn that had been raised and cut up for the purpose, weighing 150,222 pounds, and at the top with second-crop clover just as it came from the field, all under the inspection of many visitors who had been invited to witness the process. "The comments," says Professor Henry, "were as varied as the visitors. As the weather was very warm the ensilage heated rapidly, and when the visitor would run his hand down into the mass of damp-cut fodder, and find it so hot as to be uncomfortable, there would sometimes come a shake of the head and prediction of failure of some sort: 'It will burn the barn up'; 'May keep below, but will not on top'; 'Think it will be all right above where it can get some air, but below it will make a nice manure-heap.'" The silo was loaded down with an unusual weight of stones, in order to bring the more pressure to bear upon the long and matted clover-stalks; for the efficacy of the operation depends upon the prevention of heating by cutting off the access of fresh air. After the pit was closed, but little evidence of the change within was seen, only occasionally a just discernible but not at all marked odor. When the silo was opened, November 29th, the clover was partly decayed for about a half-inch down, and moldy for two or three inches below and around the sides of the pit. This was thrown out to be put on the manure-heap. The cows were a little shy of eating the ensilage at first, but after four or five feeds all ate it as naturally as they would hay.

Then the clover that had been thrown away attracted their attention, and they ate greedily even of that which was musty. A small extemporized silo was tentatively made, in the natural ground where it was well drained, without walling, and was filled with green clover. The ensilage came out in perfect condition and entirely palatable. The result of the last experiment shows how persons living where the subsoil is very compact might make a silo with either very light walls or with none at all.

How Oölite may be formed.—Mr. F. W. Putnam, in giving an account of a visit he made some months ago to the Mammoth Cave, remarks that in one of the newly discovered chambers he noticed that many fragments of stalactites and small pieces from the walls of the cave, which had fallen into a little pool, were worn round and smooth by constant attrition, occasioned by the dropping of water from the high ceiling of the chamber. Should the water cease to drip in this place, as it probably will, and that in the pool evaporate, leaving the lime to crystallize about these small pebbles, a conglomerate would be formed which would have some resemblance to oölitic limestone, pebbles of which occurred in the pool, probably derived from fragments detached from the walls of the chamber. Calling attention to the formation of "cave pearls," which he had found in Grand Avenue Cave some years ago, he remarked that should such a mass of small pearl-like lime-concretions as were found in the last-named cave ever be cemented together, the resemblance to oölite would be very marked. While he did not wish to be understood as stating that the oölitic limestone was formed in this way, he could not help thinking that a rock of similar appearance might be locally so produced under the conditions he had observed.

Lead in Food and the Industrial Arts.—M. Armand Gautier has recently published a memorandum on the dangers arising from the use of lead in food-vessels and in various arts, and on the means of counteracting them. He shows that lead may be detected in preserved vegetables, fish, lobsters, meats, in drinking-water, and water artificially charged with carbonic acid, in acid foods and drinks preserved in glass vessels, in tin dishes, in the coverings of our walls and furniture, in the leather of our boots, in our dishes, and in our glazed table-cloths. He gives a simple and practical test for the presence of lead in solder or tinned or solid metal, and for estimating the proportion of the poison that may be there. It consists in turning on two drops of acetic acid upon the surface of the metallic object, allowing it to evaporate in the air, then touching with a solution of chromate of potash, letting dry, and washing with water. The yellow chromate of lead, thus obtained, adheres to the metal, and does not change color for several days, so that the spot can be kept in evidence. When a tin thus treated shows a yellow spot it should be rejected; if it is used in a food-can the contents should be regarded as suspicious, even if the soldering has all been done on the outside, as the latest regulations require. The general use of food preparations done up in metallic boxes that are soldered with an alloy of lead necessarily results in the introduction of a little lead into the economy, and, according to M. Gautier, the proportions of lead thus absorbed, generally very weak with vegetables, are much stronger in foods rich with fats, and especially in fish preserved in oil; the oils that surround the fish are still more strongly charged with it; and preserved meats contain it in widely varying proportions. The lead appears to exist in vegetables in the shape of an albuminate soluble in the acids of the stomach, in fat-substances as an oleate and a palminate dissolved in the fats, and absorbable with them when they undergo emulsion in the digestive tube. The use of lead in a multitude of arts and trades, too numerous to be named here, leads to more perceptible and extensive poisoning than the minute quantities of the metal that reach us through our foods and food-vessels, the importance of which is indicated by the admission of an average number of seven hundred workmen suffering from it to the hospitals of Paris every year. The compounds of lead with which these workmen come in contact are absorbed by the skin, the mouth, the nostrils, and in breathing. To workmen exposed to such

danger M. Gautier advises avoidance of everything that can raise a dust of leaden compounds, of all unnecessary direct contact with lead and its preparations, scrupulous care for the cleanliness of person, clothing, tools, face, and mouth, and observance of general hygienic rules and temperance.

Disadvantages and Advantages of Bacteria.—In a paper on "Bacteria in Healthy Individuals," Surgeon George M. Sternberg, of the United States Army, considers the question, which many have been ready to ask, If bacteria are such terrible things, how is it possible that we can exist upon the earth, surrounded and infested as we are by them? "Certainly," says Surgeon Sternberg, "there would be an end to all animal life, or rather there would never have been a beginning, if living animals had no greater resisting power to the attacks of these parasites, which by numbers and rapid development make up for their minute size, than has dead animal matter." The obvious answer to the question, that living animals have the required superior resisting power, is supported by Pasteur's researches, which show that it depends very much upon certain well-defined circumstances whether the same bacterium is a harmless parasite and commensal of man and animals, or an active agent promoting disease and decay. "Nature," says Dr. Sternberg, "has placed in the living tissues of animals a resisting power against the encroachments of bacterial organisms invading and surrounding them, which is sufficient for ordinary emergencies. But when the vital resistance of the tissues is reduced, on the one hand, by wasting sickness, profuse discharges, etc., or, on the other hand, the vital activity of the invading parasitic organism is increased, the balance of power rests with the infinitesimal but potent micrococcus. . . . Experiment has demonstrated that, by some unknown mechanism, the ordinary bacteria of putrefaction, and, under certain circumstances, even pathogenic organisms, may be introduced directly into the circulation without the production of evil consequences, and that after a short interval microscopical examination does not reveal their presence in the blood." There is compensation for the damage wrought by bacteria, which is described by Dr. Sternberg with some exaggeration, and hardly sufficient consideration of the power of the normal chemical forces of nature, in these words: "On the other hand, but for the power of these little giants to pull to pieces dead animal matter, we should have dead bodies piled up on all sides of us in as perfect a state of preservation as canned lobster or pickled tongue, and there being no return to the soil of the materials composing these bodies, our sequoias and oaks would dwindle to lichens and mosses, and finally all vegetation would disappear, and the surface of the earth would be a barren and desolate wilderness, covered only with the inanimate forms of successive generations of plants and animals."

Variable Stars.—Professor A. Ritter attempts, in his recent work on the "Application of the Mechanical Theory of Heat to Cosmological Problems," to explain the origin and nature of variable stars by supposing that, stable as they appear to our limited vision, the planetary systems are subject to ceaseless recurring changes, in the course of which they go through all the phases of cosmical evolution. The speed of the revolutions of the several members of the systems being constantly retarded by the resistance of the ether, they eventually yield to the attraction of the central body and fall into it. The concussion generates heat enough to resolve the whole mass into a vapor or gas which diffuses itself through space till its surplus heat is so dissipated that the attractive force is able to overcome its power of expansion, when the vapors begin to contract, and consequently to develop heat anew. The internal heat of the contracting body at last becomes strong enough to overcome the force of gravitation, and a new expansion begins. The gaseous sphere is thus subjected to a movement of rhythmical pulsation, the temperature increasing with the contractions and diminishing with the expansions, and will appear from a distance, if the variations in temperature reach a certain degree, alternately bright and dark, or as a variable star. The duration of the pulsations will vary according to the size of the body, and the period will bear a certain relation to its density; so that we may deduce one of the

elements from the others. When our sun filled the orbit of Neptune, it probably appeared to the inhabitants of other worlds as a variable star, with a period of three hundred and forty years. The appearance of change is confined to the youth of a star; for when it has become so dense that the variations bear only a minute ratio to the absolute brightness of the body, they cease to be noticed. The gradual and seemingly permanent disappearance of stars that have suddenly shone out is accounted for by supposing their periods of change to be immensely long. As hundreds of years must have elapsed after our sun first shone out before the gaseous particles began to move back toward the center, so, if the concussion is vastly more violent than that which produced the sun, thousands of years must pass before a concentration can begin. The origin of the apparently constant nebulæ may be thus accounted for, and their irregularities of shape may have arisen from different accidents of the concussion; but changes of magnitude have been observed even in these bodies. The origin of new stars that remain may be explained by supposing that the concussion was less violent—strong enough to produce a great brightness, but not strong enough to cause immense expansion. Professor Ritter claims that spectroscopical observations of the "newer stars" are in harmony with his theory.

A newly discovered Jewish Tribe.—Mr. Henry Samuel Morais has published a short account of the Daggatouns, a tribe of Jewish origin in the Desert of Sahara, recently brought into notice in the narrative of the Rabbi Mordecai Aby Serour, of Akka, Morocco. The rabbi's account is incomplete, but we may learn from it that the people mentioned, who are scattered among the orthodox Tuaricks in the desert, "have skins perfectly white, are very handsome, much handsomer than the finest-looking Jews of Africa," and that not one of them is black. They are distinguished by the Tuaricks as Jews that have changed their belief, and seem to occupy a low social position among the tribes. The change in belief seems rather to have been a loss of belief, for it is remarked respecting the exercise of their religion that they never utter a prayer, and have no regular form of public worship, but simply invoke the name of Mohammed. To questions on the subject they emphatically answered that they did not know the Koran, and that, having descended from the Jews, and not resembling in any manner the other tribes, they could not have exactly the same religion. "Notwithstanding this," they continued, "even if we accepted their practices, they would not cease calling us converted."

The Eucalyptus in California.—Mr. Robert E. C. Stearns, Ph. D., communicated to the American Forestry Association, at its recent meeting, a number of facts respecting the cultivation of the eucalyptus in California, and the probable value of the tree. About six million eucalyptus-trees have been planted in the State during the last ten years, and several million trees of other kinds. A large proportion of the number have been planted in the streets and yards of cities, and for ornament in country estates, till, in the absence of deciduous trees, "the vistas afforded by the streets are somber and monotonous through general sameness of form and tone of color." The eucalyptus is a greedy monopolist, and, when planted in a small yard, takes all there is of it, killing out the shrubs. These objectionable facts, however, are not faults of the tree *per se*, but are only effects of injudicious planting, remediable by remanding the eucalyptus to its proper place, and by interspersing it with native and deciduous trees, for the sake of variety in the appearance. The *globulus* species of eucalyptus is the one most planted, but it is probably of less value for most purposes, aside from the fact of its rapid growth, than its harder-wooded congeners. This species, also, "which seems generally to thrive within the influence of the coast climate, where the saline quality of the coast atmosphere neutralizes the occasionally too low temperature of the winter months, often fails in the interior. 28° Fahr. is about the temperature limit as to cold." Touching the value of the eucalyptus for lumber, based upon the product of California-grown trees, "but little can be said. The time has not arrived to determine that question. The

lumber sawed in Australian mills is not made from trees of only ten to fifteen years of age, and it is probable that very few of the eucalypts planted in California are as old as fifteen years from the seed. Our native trees of so recent growth are not used for or made into lumber, and nothing but soft and sappy wood can be expected from trees so young." Facts bearing upon the profit of eucalyptus-growing for fuel purposes are furnished by the yield of twenty acres of a plantation belonging to General Stratton, of which, after charging every item of cost, and a yearly rental of five dollars per acre, the net profits were $3,866.04 in eleven years. Notwithstanding that too much may have been claimed by enthusiastic friends in relation to the sanitary and medical value of certain species of the eucalyptus, "there is enough, minus exaggeration, to justify their being regarded as of unquestionable merit."

How Flies climb.—Herr H. Dewitz has communicated to the Berlin Society of Natural History some facts that bear very strongly against the generally received theory that flies adhere to perpendicular walls and ceilings by virtue of some sucking power in their feet. He asserts that the feet of flies can not possess the sucking property ascribed to them, for they are hard and destitute of muscles. The theory has long been contradicted by the experiments of Blackwall, who found that flies could climb the sides of a jar under the receiver of an air-pump, where there was no atmospheric pressure; and who asserted that the power of adherence was due to a sticky matter secreted from the foot-hairs of flies. This assertion was generally regarded as not proved, and the case has rested there. Dewitz reports that his investigations have shown that Blackwall was right. He has watched the exudation of the sticky matter from the feet of the flies by fastening one of the insects to the under side of a plate of glass and viewing it under the microscope. A perfectly clear liquid was seen to flow from the ends of the foot-hairs and attach the foot to the glass. When the foot was lifted up, to be put down in another place, the drops of the sticky matter were perceived to be left on the glass, in the exact places where the foot-hairs had rested. The adhesive fluid appears to pass down through the hollow of the hair, and to be derived from glands which Leydig discovered in the folds of the foot in 1859. A similar adhesive matter appears to be possessed by bugs, by many larvæ, and probably by all insects that climb the stems and the under sides of the leaves of plants.

Flesh-eating no Sin.—Mr. W. Mattieu Williams gives a pointed answer, in the "Journal of Science," to the protests of a vegetarian writer against eating animal food, on the ground that it involves cruelty to living beings. No animals, he says, enjoy a more comfortable life, or are better cared for, than those we keep for food. If we did not eat them, they would be exterminated, for they would not be able to take care of themselves. Yet, in the very sight of the wonderful animal happiness that they enjoy, "the sentimental vegetarians advocate the extinction of all the pastoral bliss that has been a leading theme to poets of all ages." The final killing of them is in accordance with the order of nature, and, if we are to be denounced for it, the Creator must also be denounced for giving life, and at the same time making death one of its necessary conditions. Then, if the killing is wrong, the vegetarian kills on a far more extensive scale, "for the boiling of a cabbage involves the immolation of innocent slugs and caterpillars, and tens of hundreds of thousands of aphides are sacrificed in topping a row of broad beans, to say nothing of the millions of Colorado beetles that have been mercilessly murdered in order that ruthless, selfish man may satisfy his greed for potatoes."

Sun-Worship and the Cross in Ancient America.—Mr. F. L. Hilder, of the Missouri Historical Society, has made a study of a pottery-vessel taken from one of the mounds in the State, and finds that the ornaments upon it represent the sun, figured under four distinct designs. He draws the conclusion, from his examinations, that "the symbolic character of all these devices is so evident that it is impossible to mistake their meaning. They are all well-known emblems of that solar worship which was

so prominent in all the primitive religions of the world that it has completed the circuit of the habitable globe. As such they form an important item in the evidence to establish the fact that the symbolism employed by the ancient inhabitants of this region was far too refined and abstract to have been the outgrowth of the religious ideas of savage hunters and warriors; and that it bore a close analogy to, if not absolutely identical with, that in use among the nations of the central part of the continent when invaded by the Spaniards." In one of the forms of the figure, the sun is marked with a cross, thus giving new evidence of the universality of that symbol among mankind.

The Bacilli of Tubercle.—The "Medical Press" gives one of the clearest accounts of the experiments by which Dr. Koch has established the bacterial origin of tubercle. In pursuing his investigations, Dr. Koch used material derived both from human and animal sources. Examination of the tuberculous material deposited in various organs led to the discovery of minute organisms possessing all the bacterial characteristics of bacilli, whence the conclusion was formed that those forms of life are invariably present in such deposits. In a multitude of cases of miliary tuberculosis, bacilli in incalculable numbers were encountered in every affected situation, and the conclusion was warranted that they inevitably accompany the development at least of the disease. To demonstrate, however, that they are the cause of the affections, required the accumulation of sufficient actual proof, and Koch's claim to the gratitude of the world rests on the fact that he appears to have made this. Numbers of Guinea-pigs, rabbits, and cats were operated upon, with the result, in every case, of verifying the conclusions which the experimenter had reached. By directly transferring the tuberculous matter from diseased animals to healthy ones, through inoculation, Dr. Koch succeeded in all cases in reproducing the disease. As, however, it was still possible that the contamination might be due to a virus contained in the transferred material, rather than to the presence of microscopic organisms in it, "cultivation" experiments were introduced and conducted on a very exhaustive scale. A pabulum was found in which the bacilli grew and reproduced freely. By repeated sowings in new quantities of the nutritive matter, extending in some cases to six months, a generation of "purified" bacilli was obtained which could not by any possibility be accused of communicating virus. When these organisms were introduced into healthy animals, they never failed to reproduce themselves in incalculable numbers, and to set up all the symptoms of tuberculous infection. Thus, four Guinea-pigs were inoculated with bacilli of the fifth generation produced in fifty-four days from tuberculous matter originally derived from a human being. In each case the infected animal sickened and lost flesh, and was found when killed to have strongly pronounced tuberculosis. This took place whatever was the point in the body chosen for the injection of the infective material. When some animals were injected with healthy blood-serum at the same time that others were inoculated with bacilli, the latter sickened and became tuberculous, while the former were not affected. In another series of experiments the sputum of phthisical patients, even after having been thoroughly dried, was found to produce similar effects with the bacilli. Certain conditions seem essential to the development of the bacilli under the ordinary circumstances of communication, and further experiments will bear reference to ascertaining precisely what they are.

Neglect of the Study of Insanity.—In a paper read before the National Association for the Protection of the Insane and the Prevention of Insanity, Dr. Nathan Allen, of Lowell, Massachusetts, calls attention to the neglect in which the study of insanity is left by the medical profession generally. Acknowledging that the study of the functions and disorders of the brain presents more difficulties than any other branch of medical science, but seemingly considering this as only a stronger reason why more attention should be given to it, he finds that in very few instances is insanity mentioned as one of the subjects in the annual circulars of medical schools advertising their lectures. In only three or four schools is there a professorship or course of lectures de-

voted exclusively to mental disorders. The subject is sometimes introduced under the head of theory and practice of medicine, but is more often remanded to the lectures on medical jurisprudence; and hardly ever is a book on this subject included among the standard works of study and reference proposed for students.

The Albert Medal.—The Albert Medal of the British Society of Arts has been awarded, beginning in 1864, to Sir Rowland Hill, for postal reforms; to Napoleon III, for his promotion of art; to Professor Faraday, for discoveries in electricity, magnetism, and chemistry; to Mr. W. Fothergill Cook and Professor Wheatstone, for establishing the first electric telegraph; to Mr. Joseph Whitworth, for his instruments of measurement and uniform standards; to Baron von Liebig, for chemical and other researches; to Ferdinand de Lesseps, on account of the Suez Canal; to Mr. Henry Cole, C. B., for activity in international exhibitions and the South Kensington Museum; to Mr. Bessemer, for developing the manufacture of steel; to M. Chevreul, for chemical researches; to C. W. Siemens, for a variety of researches; to Michael Chevalier, for general economical activity; to Sir George B. Airy, for researches in nautical astronomy and magnetism, etc.; to M. Dumas, for chemical researches; to Sir William Armstrong, for distinguished engineering work and development of mechanical power; to Sir William Thomson, for electrical researches and the development of ocean-cables; to J. P. Joule, for establishing the relations between heat, light, and electricity; and to A. W. Hoffmann, of Berlin, for investigations in organic chemistry and his promotion of chemical education and research in England. The award of the medal for 1881 was to be made in May.

Tree Meteorology.—Mr. Robert E. C. Stearns, Ph. D., at the close of a paper on the estimation of the annual growths of certain trees in California, suggests the possibility of making valuable investigations into the periodicity of climates and the direction and effects of prevailing winds by the systematic study of the year-rings of trees. "We might," he says, "find so close a parallelism between rings of maximum thickness and seasons of maximum rain-fall, that we should be justified in regarding this parallelism as something more than a series of coincidences merely, by finding these coincidences so persistent as to prove a correlation; and we could, perhaps, base our weather prognostications on something more than a guess, and learn whether or not there is a periodicity or cyclical term of wet and dry years, having the data before us according to the trees selected and examined—reaching back with the pines from seventy-five to one hundred and fifty years, with the redwoods from five hundred to seven hundred years, and with the sequoias of the Sierra from twelve to fourteen centuries, to say nothing of the testimony of other trees, the madronas and oaks especially. Differences in the diameters of trees," Dr. Stearns adds, "may be traced, perhaps, to a difference in the amount of heat and light which one side of a tree receives as compared with the other; to the influence of prevailing winds according to the station, position, or exposure, or to local or general magnetic influences—local as peculiar to small areas, or general as pertaining to larger or extensive regions. An accumulation of data might show a marked and constant character in the relation of diameters to such factors of the environment; and also a marked character in the diameters of one region, as a whole, when compared with another region, where modified or different climatic conditions exist."

Habits of Wood-Ducks.—The experiments of Mr. George Irvin, of Mayville, New York, upon the capacity for domestication of different species of wild ducks, gave him the means of gaining much knowledge of the habits of the wood-ducks, which, although they would not be domesticated, bred freely within the inclosure in which he confined them. They generally begin to nest about the middle of April, and always choose trees with suitable holes and hollows in which to build, preferring for this purpose rather high elevations, and lay from nine to fourteen eggs, of a yellowish-white color, the period of incubation of which is four weeks. When the young

birds, twenty-four hours after being hatched, are ready to descend from their nests, whether low or high, the old bird comes to the mouth of the hole and takes for about a half-hour a careful survey of the surroundings, to ascertain, as it were, that no intruder is near, and then utters a low call. The ducklings seem to understand the significance of the call and quickly make their appearance in front of the hole, which often extends to a depth of from six to ten feet. By means of their toe-nails, which are hooked nearly as much as those of birds of prey, and sharp as the point of a needle, they easily manage to climb up on the inside of the deep holes, at the entrance of which they remain a few minutes huddled together about the old bird. After this, the mother again descends to the ground near the tree, and calls upon her young brood, which now drop, one by one, from their airy perch, without any apparent hesitation; for their bodies are already so thickly covered with down that they seem to fall like leaves to the ground. When the last duckling has accomplished its fall, the brood gather again about the old bird and are led by her to the nearest water, which is seldom far away, and is generally convenient to shelters and hiding-places.

The Foot, and how it should be treated.—The human foot is an instrument admirably adapted to all the various uses it has to serve, which fashion has done its best to spoil by improper treatment. The bones of the instep are so adjusted as to form an arrangement which combines in exquisite perfection the resistance of the arch with as much elasticity as enables it to bear safely the prodigious strain to which it is subjected. The whole frame of the foot is kept in position and made capable of its proper range of movement by means of muscles and tendons, constituting a living and sensitive bandage, increasing or relaxing its pull or pressure in the most exact obedience to our will. In a sound, free foot, each part of the machinery is in constant readiness to bring it into the required position, whether to lift the body, to bound, or to sustain the shock of the whole weight in coming down again, or to perform any other of a number of complications of movement. How perfectly the foot is adapted for these purposes, and is protected against too great pressure and sudden shock, is shown by the fact that such violent actions as leaping, or the being burdened with a weight twice or thrice that of the whole body, cause no uneasiness to a sound foot; the injury, if any, resulting from such exertions being usually felt elsewhere. The skin, very thin and delicate on the upper part of the foot, is thick and tough, though soft and pliable, on the sole. Beneath it is a layer of fat, strengthened by strong fibers crossing it and binding it to the muscles and ligaments. The sole can endure great pressure and even violent shocks, but is at the same time curiously sensitive, especially to the touch. It is very easily tickled. This property serves a very important purpose in walking, for the pressure upon the ground stimulates the muscles of the foot to their required activity, without any effort of the will, and indeed without our being conscious of the operation. This spontaneous alertness of the muscles, on which the energy and grace of movement depend, can be secured only by their being kept uncramped, free, and well exercised. How much the shoemaker's shoes, cramping the foot, jamming the toes upon each other, distorting the shape of the organ, and lifting the heel up so that the weight of the body is thrown upon the toes, prevent this, needs no elaboration. The lesson of these observations is that the shoe should give plenty of room all around to the foot, that the sole should be thinnest and narrowest at the "waist," where elasticity is wanted, broad and thick at the tread, where protection is most required, and that no one should be ashamed of the size of his foot. "A well-formed large one is a far pleasanter sight than the smallest one distorted."

A Lion-Tamer's Method.—A curious history, and one that sheds many gleams of light upon the character of beasts in the menagerie, is that of Henri Martin, the lion-tamer, who died, ninety years old, quietly at his home, "among his collections of butterflies and his books of botany." Martin, according to his own letters, began to cultivate his gift of control over animals in the days

when he was connected with a circus, by acquiring an extraordinary power over horses, which he taught every trick known to the profession, and some which have hardly been exactly paralleled. From this he went on to taming wild beasts; and, soon after he had started business as part proprietor of a menagerie, he had labored eight months in training a royal tiger, and had taught a spotted hyena to pick up his gloves. He was never seen with a whip in his hand; but he crossed his arms, and gave his animals the word of command to leap on and off his shoulders; and he considered his method infinitely superior to that of the tamers who go through their business chiefly by the terrorism of a heavy whip and a revolver. Their beasts obey them, but, he said, "they are not tamed as mine were, and, when one of them rebels, you can judge the tragic result from the tragical end of Lucas." One day, Martin told his wife that he anticipated trouble with his lion Cobourg, who was then in a dangerous state of excitement. She begged him to put off the performance, but he said: "No; for, if I should do it once, I should have to do it every time the animals have caprices." The next night his forebodings were fulfilled. Instead of performing his part properly, Cobourg crouched low and dug his talons into the stage, and his eyes flared. Martin had no weapon at command except a dagger in his belt—"I have said, never a whip." Instead of obeying orders, the lion leaped at Martin, and a combat occurred, in the course of which the lion took Martin up in his mouth and shook him in the air. Martin struck the animal over the nose for a second time, and then, feeling his strength exhausted, gave himself up for lost, and turned his back to the beast, so that at the next spring it might attack the back of his neck, and so "make an end of the business. . . . But two seconds passed, two seconds that seemed to me an eternity. I turned around; the lion's mood had changed. He looked at the audience, he looked at me. I gave him the sign to go. He went away as if nothing had happened." It was fourteen weeks before Martin could perform again, but then the lion worked well as usual, and continued to do so for four years without any more caprices. In taming one of his tigers, Martin began by taking the brute's attention off the door of the cage, and then, armed with a dagger, went rapidly into the cage and stood looking at the tiger, which for some minutes lay motionless, staring at him. Then, feeling a shiver, and knowing that if the tiger saw it all would be over with him, he went swiftly out. At the end of a fortnight he went again into the cage, and this time staid there half an hour. A third time he paid the tiger a visit of three quarters of an hour. "The fourth time the tiger, trembling at first, lay down before the pygmy who braved it." To tame a hyena, Martin wrapped his legs and arms with cords, and protected his head with handkerchiefs, and then, walking into the cage, went straight to the animal and offered it his fore-arm. The hyena bit it, and the tamer, looking steadily in its eyes, stood motionless. The next day he repeated the experiment, substituting a leg for an arm; "and all the time Martin's black pupils were flashing into the gray eye of the hyena. The beast gave up, cringed, and smelled the feet of the master." Martin tamed his subjects by his personal influence alone; and Charles Nodier once said of him: "At the head of an army Martin might have been a Bonaparte. Chance has made a man of genius a director of a menagerie."

A Merovingian (Frank) Grave-Yard.—M. Georges Lecocq has described some articles which he has recovered from a cemetery of the Merovingian period at Caulaincourt, France. He opened 186 graves, and found in them 156 coffins of wood, 30 of stone, and 464 articles of glass, iron, bronze, ivory, coins, beads, flints, etc. The graves were generally well aligned and directed from east to west. The stone coffins were made, some from a single block, more from two or three blocks, and were wider at the head than at the foot. The covers were flat or tectiform, and always composed of two or three slabs. These sarcophagi all contained wooden coffins. In most of the burials a stone was placed over the breast. The race of men whose burial-place this was, do not appear to have been essentially different from the present race. One skull, which particularly attracted attention, had a hole in it exactly like what

a gunshot would produce. The numerous articles of earthenware presented a great variety of forms, and were both plain and decorated. The iron articles were all very much oxidized, so that traces could hardly be detected of the silver with which some of them had been damascened. Lances were put at the head of the dead and arrows and battle-axes along by the legs. The bronzes were made of different alloys of copper and tin and other metals, and included fibules in the shape of a bird (single- and double-headed paroquet), round belt-plates, and handsome little shoe-ornaments.

Egyptological Discovery.—Great progress has been made within twelve months in Egyptological discovery. M. Marriette, the official curator of the antiquities of the country, who died in January, 1881, had, just before his death, opened three pyramids, two of them those of monarchs of the sixth dynasty who were among the most distinguished kings of the old empire—Pepi Rameri, who, according to Manetho, reigned a hundred years, and his son and successor Rameri. The pyramids were richly adorned with inscriptions, and the discovery pleasantly supplements the valuable biography we already had of a chief officer of that period, relating the wars with the negroes and other events, which form one of the most satisfactory historical documents which the ancient empire has yet furnished us. Professor Maspero, who was appointed to succeed M. Marriette, shortly after he took his office explored the pyramids of a still earlier monarch, Unas, the last king of the fifth dynasty, which was also richly decorated and contained inscriptions, mostly parts of the ritual, a sarcophagus of black basalt, and remains of the mummy, bearing marks of the work of the ancient tomb-breakers. The excavations of the pyramids are to be continued in the expectation of finding them to confirm M. Maspero's theory that the pyramids from Gizeh to the Fayoom are a series containing in succession the bodies of the kings from the fourth to the thirteenth dynasty. A second great discovery of no less importance was made in July at the caverns behind the Deir-el-Bahari, or temple of Hatasu, near Thebes. Attention had long been drawn to the antiquities which had been offered to travelers for many years past, and which it was believed must come from some hiding-place known only to the Arabs. M. Emil Burgsch secured the arrest of the Arab who seemed most concerned in these dealings, and succeeded in tracing the articles to their source, the cave among the hills where the royal mummies had been carried and deposited for security against invasion during the twenty-first dynasty. The mummies are twenty-seven in number, several of them being of kings, queens, and princesses, and persons of distinction of the eighteenth and intervening dynasties to the twenty-first, and with them were thousands of objects—amulets, statuettes, papyruses which are expected when read to prove of great value, and a leather tent of a king of the twenty-first dynasty. Among the mummies are those of Raskenen, a king preceding the eighteenth dynasty; of Queen Ansera, Amenophis I, and his wife Ahmes Nofertari, Thothmes II, and Thothmes III, of the eighteenth dynasty; Rameses II, the supposed Pharaoh of Moses, of the twentieth dynasty; Queen Notemit (to whom the "Prince of Wales's papyrus" in the British Museum was originally attached); and King Pinotem II, of the twenty-first dynasty. Cases and other articles were also found belonging to other distinguished monarchs of the eighteenth and nineteenth dynasties, The cave in which the remains were found is supposed to have been originally the tomb of Queen Ansera.

The Manageable Zone of Anæsthetics.—M. Paul Bert has announced some discoveries of great value respecting the mode of action of mixtures of anæsthetic vapors and atmospheric air upon the animal organism. He applies the term *manageable zone* to the different degrees of admixture, rising from the proportion of anæsthetic which is insufficient to put to sleep, to the proportion which will cause immediate death. In the case of chloroform and ether the mortal dose appears to be exactly double the minimum anæsthetic dose. Anæsthesia takes place in the middle of the manageable zone very rapidly and without danger, so that the animal may be left for two hours in the anæsthetic atmosphere without any one being concerned about him.

It is not necessary to insist upon the contrast thus afforded between this method of administration and the one that has hitherto been used, in which the operator, making his patient breathe dense chloroform directly into his nostrils, has to exercise the greatest caution lest he kill him. The manageable zone of ether is a little more than three times as wide as that of chloroform, while that of the protoxide of nitrogen is considerably wider than that of ether. Here we see why ether is less, and the protoxide of nitrogen still less, dangerous than chloroform. M. Bert's researches further show that it is not so much the absolute quantity of the anæsthetic that should be regarded as the proportion in which it is mixed with air. A dog can safely be made to absorb many times as much chloroform as would kill him, if it were pure, provided it is so diluted as to bring its strength within the manageable zone.

Poisonous Food-Colors.—The prefect of police of Paris has expressly forbidden the use of any of the following substances in coloring sweetmeats, liquors, and foods: *Mineral Colors.*—The compounds of copper—blue verdigris, mountain blue. Compounds of lead—oxides of lead—massicot and minium. Oxychloride of lead—Cassel yellow, Turkey yellow, Paris yellow. Carbonate of lead—white-lead, flake-white. Antimoniate of lead—Naples yellow. Sulphate of lead. Chromates of lead—chrome yellow, Cologne yellow. Chromate of baryta—yellow ultramarine. Compounds of arsenic—arsenite of copper, Scheele's green, Schweinfurth green. Sulphide of mercury—vermilion. *Organic Colors.*—Gamboge and Naples aconite. Fuchsine and its sub-products, such as Lyons blue. Eosine. Nitro-derivatives, such as naphtol yellow and Victoria yellow. The use of these substances in coloring wrapping-papers for any kind of food is prohibited, and manufacturers and dealers will be held responsible for any accidents that may occur through disobedience of the prefect's order.

The Meteorograph.—Messrs. Van Rysselberghe and Schubert exhibited at the Paris Exposition of Electricity an instrument they called a meteorograph, for representing by means of continuous curves drawn automatically upon a sheet of zinc all the principal atmospheric variations, the knowledge of which is indispensable in meteorological investigations and in making forecasts of the weather. M. Theorell, of Stockholm, exhibited another machine, of a more complicated character, which indicates, by printed figures in six columns on an endless roll of paper, the hour when the observation is taken, the velocity of the wind, its direction, the indications of the wet and of the dry thermometer, and the indications of the barometer. Notwithstanding the complicated character of the machinery that must do so much, the instrument has borne admirably the test of use at the University of Upsala, where it has been employed for two years in registering the condition of the atmosphere every quarter of an hour. For immediate use in the observatory it is not as convenient as the Rysselberghe instrument, the graphic curves of which can be read off and appreciated at sight; but it is much its superior for use in cases where the facts have to be transmitted by telegraph.

Sea Telegraphy for Ships.—M. Menusier has proposed a plan of telegraphy for the use of ships at sea. Upon his cable, which he would lay from the French coast to New York, with a branch to Panama, he proposes to ingraft at distances of about one hundred and eighty miles, representing a ship's daily sailing distance, vertical cables rising to the surface where the ends may be held up by buoys. To the main cable he would also add secondary cables thirty or sixty miles long, forming cross-cables, like great arms stretching out on either side, to which other vertical cables would be attached, each to be held in place by its surface buoy. Thus it could rarely happen that a ship keeping on the regular course would not be able to meet one of the buoys every day. Each buoy should have its number and its place marked on a special chart. If a ship wishes to send a dispatch, it attaches the wires of its own telegraphic apparatus, one to the cable that is held up by the buoy, the other to the buoy itself, which is of course in communication with the earth-currents. M. Menusier professes to solve the principal difficulty in the way of the successful oper-

ation of his invention, which is that of fixing the buoys so that they shall not be removed by storms, but declines to make his plans public on account of the defective condition of the patent laws. He has, however, explained it to competent navigators, and they are said to regard it as practicable.

American and European Palæolithic Implements.—Mr. Henry W. Haynes has compared the argillite implements found in the gravels of the Delaware River at Trenton, New Jersey, with the palæolithic implements of Europe, by a personal inspection of both, to ascertain to what extent they correspond in character as objects of human workmanship. He traces many striking resemblances between the two groups. The argillite implements are, indeed, of ruder workmanship than the European flints, but that is because the material from which they are made is less susceptible of being finely worked. The types of the two classes of implements are, however, remarkably similar, and the Delaware objects are equally well adapted to any purposes to which the European implements are capable of being applied. Regarding the character of the formations in which the implements are found, the general appearance of the country and the gravels present a striking resemblance to what he has seen in the places where the palæolithic implements in Europe were found. He, therefore, considers the argillite objects of the Trenton gravels to be true palæolithic implements.

Disease from Coal-Dust.—M. Paul Fabre has published some observations on the part which coal-dust plays in the pathology of coal-miners. The effects which result from the accumulation of dust in the respiratory passages are obvious and need no particular description. Coal-dust does not exert any special action on the skin. The parasitical pests, the origin of which some authors have attributed to coal-dust, never appear except when the chambers of the mines contain water holding some irritant in solution or suspension. Coal-sorters, who work on the surface, live in an atmosphere containing coal, and handle as much coal as the workmen in the mines, but do not suffer from eruptions. Nearly all miners are marked with characteristic scars of a clear blue color, which, indelible as real tattooing, follow every wound produced by splinters of coal. Coal-dust in the air in a state of suspension may produce a slight degree of simple conjunctivitis; affections of the cornea and iris are also sometimes observed, resulting from blows inflicted by fine fragments of coal. They are generally cured after the irritating splinter has been removed. Miners are frequently affected with defective hearing and other troubles of the ears, which most frequently arise from a stoppage of the extreme auditory conduit with masses of dust that have been cemented into a wad by the ear-wax. This may be easily removed, and the irritation of the ear-passages may be cured afterward by washing.

What Perils might come out of a Tunnel.—The scheme to tunnel the Channel has excited great alarm, and called out formidable remonstrances in England. The objection most prominently urged against the proposed work is that it would expose the country to a constant menace of invasion or treachery. The French might fill the tunnel at any time with soldiers in the guise of innocent passengers, and seize the English approaches so firmly that it would be impossible to shake them off, before the people had begun to imagine that danger was near; and the Irish republicans might form a league with the French, and, seeing that the telegraph wires were cut, destroy communication within the kingdom, thus increasing the danger, which, as it was previously presented, seemed as great as it possibly could be. The single defense of the English would be the power of blowing up the tunnel suddenly and unexpectedly, "and what would that power be worth? The premier might think himself justified in destroying twenty millions of property and impairing twenty-two millions more; . . . but also he might not. He might be an undecided man, or a man expecting defeat by the opposition, or a man paralyzed by the knowledge that the tunnel was full of innocent people whom his order would condemn to instant death in a form which is at once most painful and most appalling to the imagination. . . . The

responsibility would be overwhelming for an individual, and a cabinet, if dispersed, takes hours to bring together." The danger of panic, to which the people and the markets would be constantly exposed, in the view of such apprehensions as these, is one the effects of which would be real. Such objections to the tunnel have found formal expression in a remonstrance which has been signed by men whose names carry weight everywhere, and have at last brought about a suspension of the project. A very curious objection, which Americans can hardly appreciate, is suggested in "The Spectator." It is that the tunnel would turn England into an outlying peninsula of the European Continent, and "would be almost purely mischievous, as slowly destroying the insularity and separateness of the national character."

Color-Names and Color-Sense.—Dr. B. Joy Jeffries, in an article in "Education," calls attention to the fact that the power to give right color-names does not indicate the possession of a right perception of colors. "A blind child will give the name of the color of grass, trees, apples, bananas, bricks, its companion's clothes, and perhaps even of hundreds of objects, the color-name of which it has learned. So, also, the color-blind boy will do the same. It is one thing to learn the color-name connected with a remembered object, and a very different thing to connect the right name with the sensation a green color arouses. Here has been the mistake which object-teaching has rather fostered than corrected." It is evident, he adds, that teaching color in the schools must embrace the detection of color-blindness in the boys, the learning the names of the commonest colors at least, the sharpening of the appreciation and discrimination of colors, and thus the gradual education of the color-sense. Instruction should begin in primary or Kindergarten work, and be steadily pursued through school-life. Congenital color-blindness is incurable, but it may be somewhat palliated. It is not exhibited as strongly in artificial as in natural light. Looking through a piece of lemon-colored glass will help the color-blind in daylight or electric light; and the same is true of looking through a solution of gelatine stained with fuchsine. No temporary or permanent change takes place in the color-sense under these circumstances, but alterations of light and shade are made which the color-blind have learned, unconsciously, to avail themselves of.

NOTES.

In our notice, in the July number, of the death of Professor W. B. Rogers, we ascribed it, following the newspaper reports, to apoplexy. We now learn from his brother, Professor R. E. Rogers, that the deceased died from heart-disease. Professor Rogers's physicians pronounced the cause of his death to be "an attack of the heart, in which life was extinct before his body reached the floor."

Antoine Breguet, co-editor with Dr. Charles Richet of the "Revue Scientifique," in Paris, died of a disease of the heart on the 8th of July, in the thirty-second year of his age. He was distinguished in science chiefly as an electrician, and took a conspicuous part in the management of the International Exposition of Electricity of last year. Among his earlier writings was a paper on the theory of the Gramme machine, which was published in the "Annales de Chimie et de Physique." He contributed many articles to "La Nature" between 1875 and 1878; and became co-editor of the "Revue Scientifique" on the retirement of M. Alglave from that journal in 1880.

Mr. Albert S. Gatschett, in a study of the Indian languages of the Pacific States and Territories, and of the Pueblos of New Mexico, disputes the affinities which are supposed by many to exist between the Aztecs and the Pueblos. The oldest and most important characteristics of race and language, he alleges, are far from being common to both races, and even secondary and more recent characteristics, as implements, manners, customs, laws, government, religions, beliefs, worship, and traditions, have not been shown to be identical in them. A comparison of all of the four languages of the Pueblos of New Mexico and Arizona results in showing that none of them have sufficient affinity with Aztec to justify a classification with it.

The French Department of Public Works reports that of the 39,938,126 metres representing the total length of the national highways of the country, 23,731,928 metres may be bordered with trees. Of this distance, 14,335,311 metres have already been planted with 2,691,698 trees, leaving 9,396,617 metres yet to be planted.

THE editor of the "Medical Press" has visited a canary-bird, in the possession of Dr. J. MacGrigor Croft, that can talk. He says he found that the bird could pronounce a good number of sentences, "clearly imitative of the voice of the lady who had care of it since its early youth," and that "the effect produced by the clear, sweetly uttered sentences pronounced by the bird is almost weird at first; but the feeling of wonder thus created quickly gives rise to a sensation of exquisite pleasure, which is deepened as the little creature suddenly, at the end of a sentence, rushes off into an ecstasy of song."

MR. CRAIG, of Montreal, has produced a novel effect in the electric light by the device of placing his reflectors under the light and throwing the rays upward to the ceiling. It is found that by using this method the light, as reflected back from the ceiling, falls upon the persons below much softened, and far more agreeable in tone than when reflected directly downward in the usual way. The glaring center of light is hidden by the reflector below it, and no longer offends the eyes. Objects not exposed to direct light are not in shadow, as in cases of ordinary reflection, but the whole effect is described as like that of the sun in the zenith.

MOUNT ETNA has been in a half-active condition ever since the great eruption of 1879. Hardly a month has passed in which it has not ejected smoke and sand with greater or less violence and persistency. The outbursts have been accompanied by the strong tremblings of the ground, and the intense subterranean noises which commonly precede the great eruptions, but there has been no emission of lava. Such frequency of eruptive paroxysms, ending in simple jets of dust, is unprecedented in the long history of Etna.

THE "Echo of Japan" says that a cave near Beppo-Moura, Japan, had not been entered by any one for several generations. According to popular belief, a god made his abode there, and was ready to punish with death any one who violated his privacy. One of the tribe of doubters recently ventured in, and found there the veritable god whom the mass of mankind worship. The ground was strewed with nuggets of gold. A preliminary examination of the spot has been made, and shows that it is extraordinarily rich in the precious metal.

IT is estimated that twenty-nine per cent of the acreage of Europe is still in timber. Forty per cent of the enormous territory of Russia is in forests, and of this two hundred million acres are in pine-woods. Thirty-four per cent of the territory of Sweden and Norway is occupied with woods of useful timbers, twenty-six per cent of Austria, twenty-seven per cent of Germany, seventeen per cent of France, seven per cent of Spain, the timber being cork, oak, and chestnut, five per cent of Portugal, and four per cent of Great Britain. Scotland is the only part of the British Empire (including the colonies) in which the planting of timber is going on to any considerable extent. Sweden is now the country from which the world's supply of fir timber and deals chiefly comes.

DR. J. R. BLACK of Newark, Ohio, in a lecture delivered at Columbus, makes a well-conceived plea for giving more attention to physical education, saying: "To impart a knowledge of the three R's is well, but is it not as well to impart a knowledge of how to live healthy lives? Is not a strong, healthy, self-made man better than a highly cultured weakling? Let the State, as educator, attend to this point, earnestly and thoroughly, and the results would be that, besides gaining for itself a better soldiery in times of peril, there would also be an increased immunity from crimes against the State, a diminution of the conditions which produce disease and pauperism, and the rendering of the life of each more joyful and serene."

IN a paper on the aurora of April 16 and 17, 1882, which was read before the American Philosophical Society, Mr. H. Carvill Lewis points to the occurrence of remarkable auroral displays at this time, as affording a striking confirmation of the periodicity of these phenomena. "It is just ten years," he says, "since the last auroras of importance occurred, and the period of ten to twelve years between maximum auroral displays may be regarded as firmly established. The coincidence of this period with that of most numerous sun-spots shows a direct connection between the electrical condition of the earth and sun. At the present time the sun is exhibiting remarkable disturbances."

NEWS has been received in Paris of the death of Dr. Crevaux, who had started from Buenos Ayres on a second exploring expedition in South America, designing this time to ascend the Paraguay River and its tributaries and thence pass to the valley of the Amazon, whence he would descend the Tapayos. His company appears to have been murdered by a horde of cannibals. On his previous expedition, in 1879, he determined with the compass the course of six rivers, two of which belong to Guiana, and four are tributaries of the Amazon. While a little was known of three of these rivers, the Maroni, Oyapok, and Issa, two of them, the Parou and the Yari were virgin to all exploration, and of the Japura, which is fifteen hundred miles long, four fifths of its course were unknown.

RUDOLF VIRCHOW.